MACHINERY

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MAKING NEW DEPARTURE BALL-BEARINGS*

MACHINING AND GAGING METHODS EMPLOYED IN PRODUCING THE "TWO-IN-ONE" BEARING

BY CHESTER L. LUCAS†

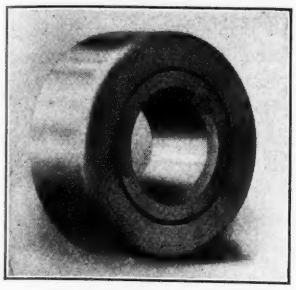

Fig. 1. The New Departure Two-in-one Bearing

THE factory of the New Departure Mfg. Co., Bristol, Conn., is now being operated to its full capacity in the manufacture of ball bearings. This healthy state of business is largely due to the increasing number of uses to which ball bearings are now being put and the realization of the economy effected by their use. But a few years ago, the principal use to which ball bearings were put was in the main bearings of the bicycle. From this, however, the field for the use of the ball bearing has broadened until it now is an important factor in the mechanism of automobiles, and is making rapid strides in the machine tool field. The future bids fair to see ball bearings in general use in machine tools. In order to give the readers of MACHINERY a general insight into the ball bearing industry,

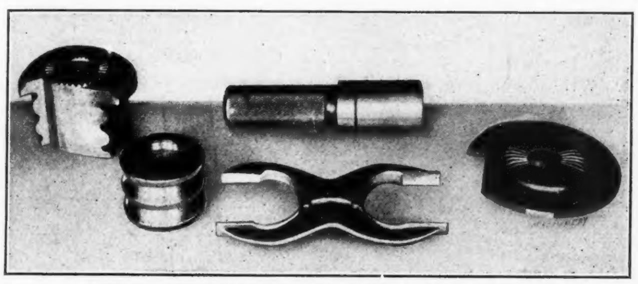

Fig. 2. Special Tools used in Machining the Cone

this article will describe briefly the machining operations connected with making the parts of a typical bearing.

The New Departure Mfg. Co. makes three distinct types of ball bearings, namely: the single-row, the double-row, and the radax. These, of course, are made in numerous sizes, and as it would be obviously impractical for us to take up the description of the manufacture of more than one, the double-row ball bearing has been selected on account of its general utility

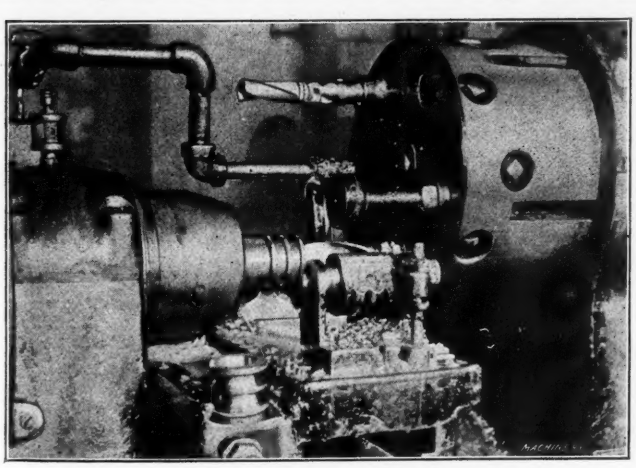

Fig. 3. Machining the Cone

as well as on account of the interesting machining operations connected with its manufacture.

The double-row ball bearing is illustrated in Fig. 1, and in Fig. 6 it has been shown in side elevation and in section in order to make the construction and relation between the several parts as clear as possible. It will be seen by a glance at the latter illustration that the bearing has been designed particularly to resist both radial and thrust stresses. Moreover, on account of the two rows of balls, its capacity for load-carrying exceeds that of any other type of bearing, and it is more efficient than two single-row bearings would be

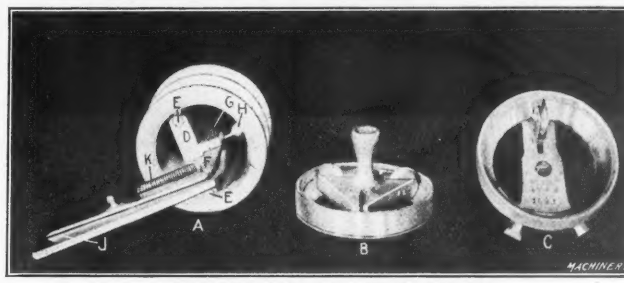

Fig. 4. Gages used on Bearing Parts

placed side by side. In the double-row bearing it is assured that each row of balls will carry a proportional part of the load, a condition mechanically impossible in two separate bearings. The parts of this bearing are, the cone or inner member, the two cups or outer members, the two bronze ball separators, the steel shell which holds the bearing parts together, and, of course, the steel balls themselves.

Turning the Cone

In taking up the machining of the parts of the New Departure bearing itself, the cone naturally comes first in order.

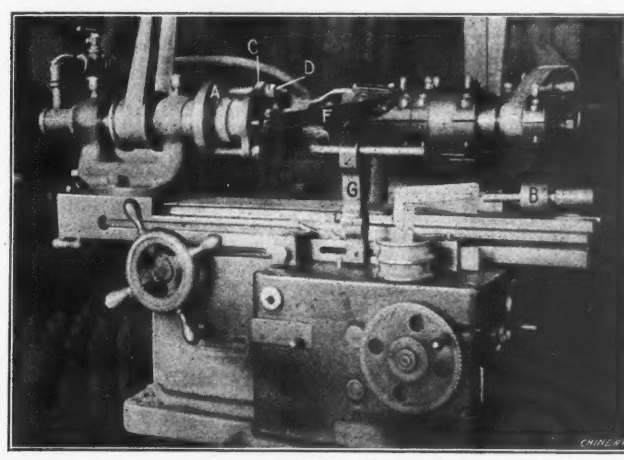

Fig. 5. Grinding the Cone Bore

This part is shown in detail in Fig. 8. By referring to the illustration Fig. 3 it will be noticed that the production of this cone is a simple screw machine job and is handled effectively on a Cleveland automatic. The working tools may be plainly seen in this illustration, and it will be noticed that circular forming tools are used. Attention is called to the fact that these forming tools are made from low carbon steel and carbonized. The cone is first formed, the forming tool being so shaped as to finish the end of the bar and partly sever the piece, as well as to turn the races for the balls. The piece is then drilled, reamed and cut off. Fig. 2 is shown to illustrate the forming tool, cut-off tool, plug gage and limit gage for the race section. It will be noticed that the sides of the cut-off and forming tool are radially serrated to facilitate holding in the forming tool fixture.

Grinding the Cone

The cone and the cups which will be subsequently described are, of course, hardened. The first operation in grinding the cone after hardening is shown in Fig. 5, in which is illustrated a special grinding machine for grinding the bore

* For additional information on this subject previously published in MACHINERY, see "Ball and Roller Thrust Bearings," August, 1912, engineering edition, and articles there referred to.
† Associate Editor of MACHINERY.

of the cone. For this purpose, the cone is held on the faceplate *A* of the machine illustrated, and it is located thereon by means of plug *B* shown on the end of the table. As will be noticed, this locating plug has a pilot which fits into a corresponding hole in the body of the faceplate. By means

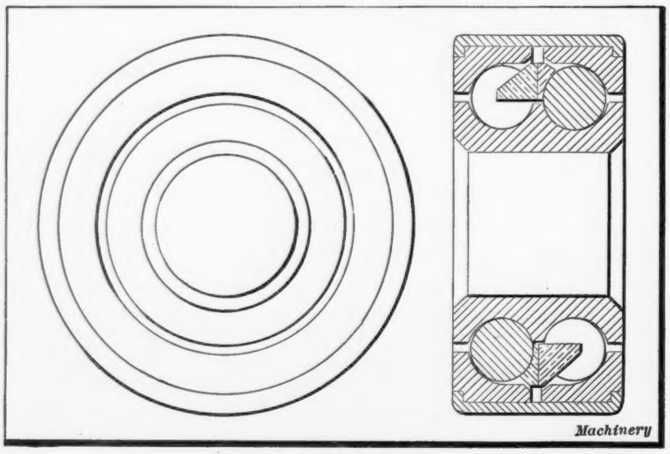

Fig. 6. Details of Bearing

of the larger section of the locating plug, which is a close fit for the bore of the unground cone, the work is located centrally under the clamping plate *C*. This clamping plate is held against the work by two retaining screws *D*. When released, the clamping plate is held back against the heads of the screws by means of spiral springs. A test indicator *F*, mounted on the bracket *G*, may be swung into position to prove the alignment of the work before grinding. For this

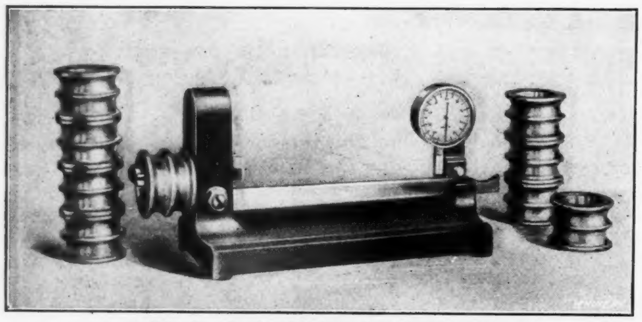

Fig. 7. Gaging Fixture for Cone Bores

and succeeding grinding operations on this class of work which will be described, the speeds used are 300 R. P. M. for the work spindle, and for the grinding wheel a peripheral speed of 5000 feet per minute is employed.

The accuracy of the grinding of the bores of these cones is held to 0.0005 inch, and this accuracy is tested from time to time by means of the special gaging device which may be seen within the bore of the cone in front of the machine. This

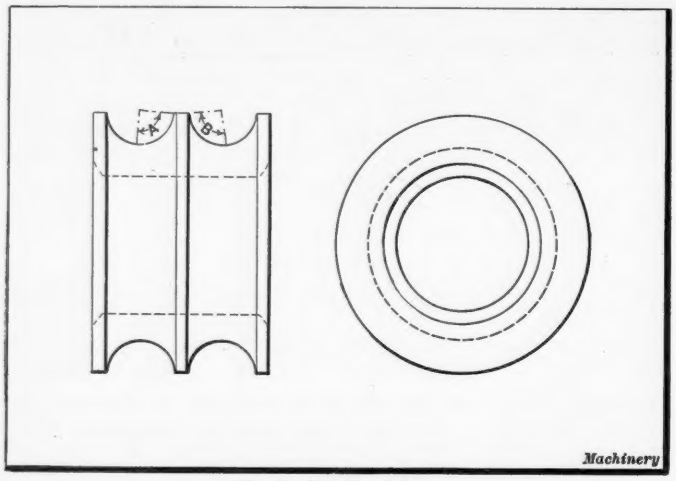

Fig. 8. Details of Cone

gage is shown in another position at *A* in Fig. 4. In this illustration it will be seen that the gage consists of a body *D*, supporting at its outer ends two hardened steel bearing pins *E*, and hinged at a central location is gaging arm *F*, fulcrumed on stud *G*. The short end of this bent lever terminates in a ball *H*, while the long arm ends in a needle point which indicates the size of the bore upon the graduated surface *J*. By means of spiral spring *K*, the gaging lever remains normally at its outermost position. Thus, by merely inserting the gage in the bore of the cone, the exact size is at once indicated upon the graduated section. By gaging from a three-point bearing, maximum accuracy is secured.

The grinding of the races in the cone is illustrated in Fig. 10, in which the cone *A* may be seen upon the arbor *B*. The grinding wheel *C* has a formed face and is used for finishing the races. By referring back to Fig. 8, it will be noticed that the balls bear only upon the two inner sides of the races along the section indicated by *A* and *B*. This, of course, facilitates meeting the requirements demanded in grinding the races, and the operation resolves itself into grinding these two sections of the cone races at correct radii whose centers are located at proper distances from each other. Referring again to Fig. 10, indicating gage *D* is used to locate the cone at the proper position upon the arbor *B*, after which one of the races is ground. Then by moving the wheel the proper distance to

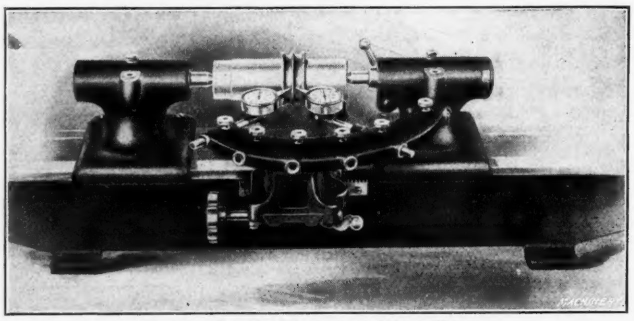

Fig. 9. Gaging Fixture for Cone Races

the left, the other radius is ground, which completes this part of the work.

Gaging Fixtures for Finished Cones

The grinding of the cones is held within close limits of accuracy. To assist in maintaining proper standards, the two gaging fixtures shown in Figs. 7 and 9 are made use of. In Fig. 7 is shown the method of gaging the cone bores. This fixture is similar to the one shown at *A* in Fig. 4, but it is far

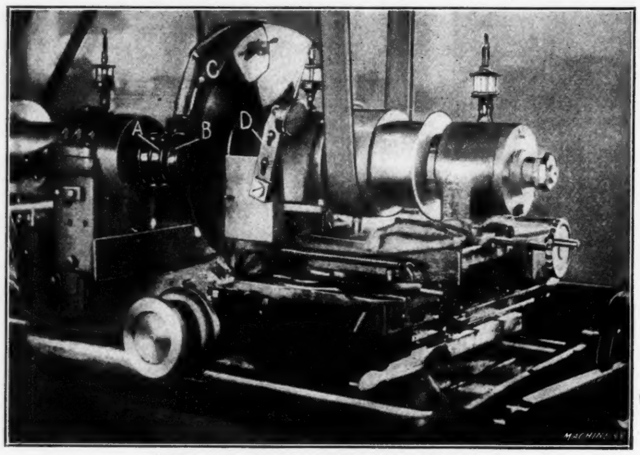

Fig. 10. Grinding the Cone Races

more accurate. The cones are slipped over the stud which may be seen at the left-hand end of the fixture. This stud is fitted with a two-point bearing, and the gaging arm forms the third point. A multiplying lever extends to the other end of the fixture and the end of this lever bears against the plunger of the dial gage shown. Any variation in the size of the bore is thus multiplied ten times and an error of 0.0001 inch is thus indicated as 0.001 inch on the dial.

The machine shown in Fig. 9 is used for determining the accuracy of the ball race grinding. This machine is fitted with two indicators connected with the dial gages shown, each of which acts upon one of the ball races. The cone is held upon an arbor centering it, and the machine indicates errors of 0.0001 inch in either parallelism or concentricity of the races.

Machining the Cups

The cups of New Departure ball bearings are made from drop forgings, and the general lines of the finished cup are

shown in Fig. 11. The first operation in the machining is shown in Fig. 12, being done on a Fay automatic lathe. In this illustration, the work A is shown gripped in a universal chuck, the jaws B holding the work firmly from the outside. Mounted on carriage C, is the forming tool, which is fed into

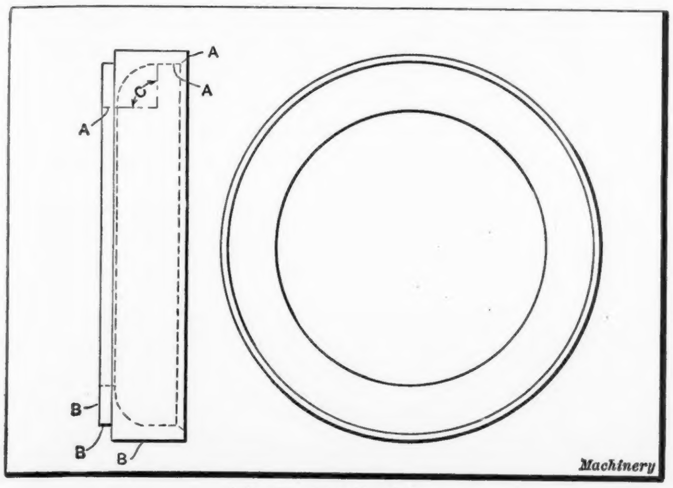

Fig. 11. Details of Cup

the work, producing the shape required for the ball race. At the same time, facing tool D is at work finishing the edge of the cup. Referring to Fig. 11, the surfaces indicated at A are finished in this operation. Two of the gages used in checking the turning operation of the inside of the cups are

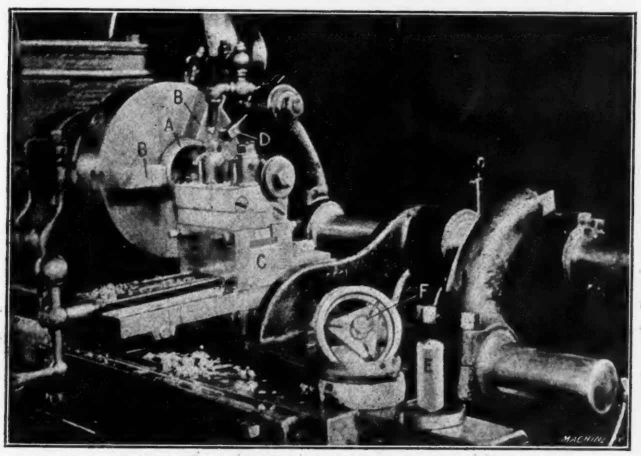

Fig. 12. Machining the Inside of the Cup

shown at E and F, E being the plug gage for testing the interior diameter, while F is the radius gage for checking the internal diameter and radius of the turning of the race.

The semi-machined cups next go to another Fay automatic lathe, where the outside parts of the work are machined.

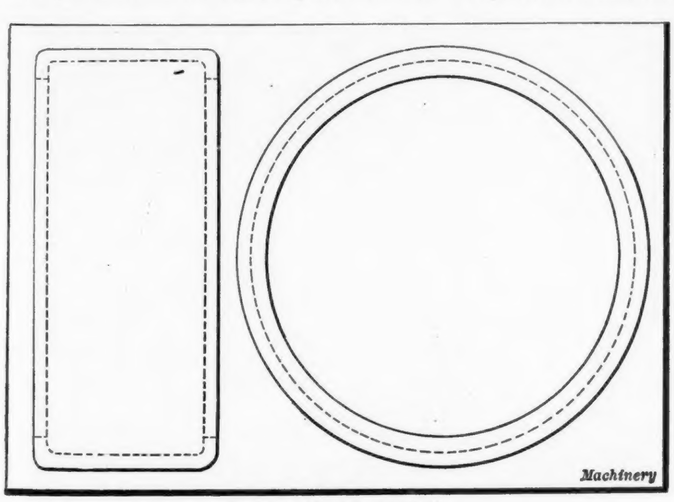

Fig. 13. Details of Shell

This operation is clearly shown in Fig. 14. The work is held in a special chuck A, the principal parts of which are the expanding jaws B which grip the work by the inside edge and are expanded when the operator turns in the central tapered screw C. The work being thus securely held, the outside face is turned by a combination of turning tools on the carriage D. These tools are located at a fixed distance apart on carriage D and operate simultaneously upon the work. While the edge of the cup is being turned, facing tool E is at work finishing the face of the cup. The accuracy of these turning operations is checked by three gages, of which the one shown in part at F gages the outside diameter, the one shown at G checks the turning of the face and edge, while that shown at H controls the thickness of the cup.

Grinding the Cups

The Norton automatic grinding machine shown in Fig. 19 is used for grinding the outside edges of the cups. The operation of the machine is extremely interesting, and is essentially as follows: The cups are fed into the chute A, dropping down against a pin whose movement is controlled by slide B automatically operated through link C. This slide is withdrawn, allowing one cup to drop between the spring

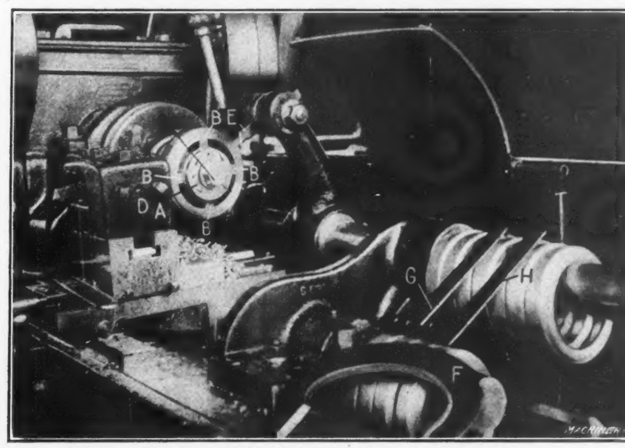

Fig. 14. Machining the Outside of the Cup

plungers of the grinding machine. These plungers correspond to centers, and their purpose is to locate and drive the work. After being chucked, the grinding wheel is passed across the face of the work, the number of times having been previously determined in accordance with the finished size desired. After the cup has been ground, the plungers automatically

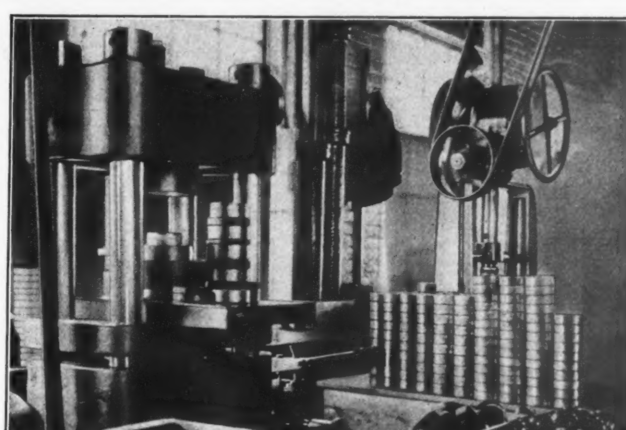

Fig. 15. Presses for Assembling Bearing Parts

open, allowing the ring to drop upon an endless belt while a new piece is being received by the plungers. The ejected piece is carried by the endless belt to the box containing the completed work, which may be seen at the left of the machine.

From time to time, the grinding of this automatic machine is checked on the Ames gage, shown on the standard at the left of the machine. The cups are slipped under the gaging arm until they reach the stop at the left. Errors of 0.0001 inch are magnified on the dial and thus easily perceptible.

Grinding the Cone Races

From the automatic grinding machine, the cups go to the oscillating machines which grind the races. Working parts of one of these machines are shown in Fig. 18. The cup is held by a magnetic chuck A, being located centrally thereon by means of fingers B. The current is supplied to this magnetic

chuck by means of feed wires C which run to a contact constantly bearing on a similar contact flange on the rear side of the chuck spindle. The wheel spindle D carries a grinding wheel whose edge has been shaped to a radius slightly smaller than that of the race to be ground. The oscillating head of the machine, which carries the chuck and work, is located so that the path traversed by the work coincides with the radius of the race. This location is reached by moving the head to or from the oscillating center upon the slide. The

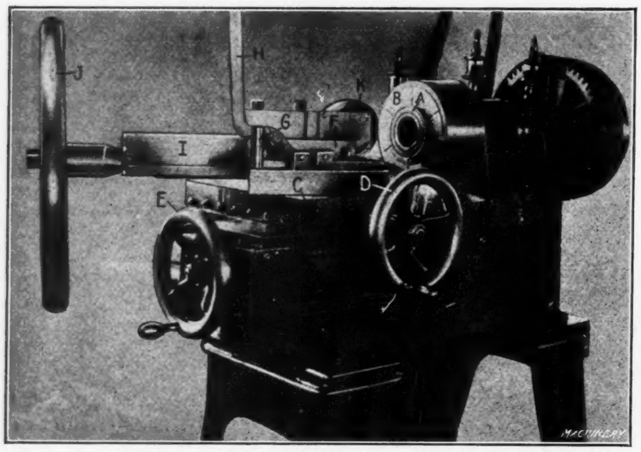

Fig. 16. Spinning the Edge of the Shell over the Assembled Bearing

oscillating mechanism consists of a crank and arm at the rear side of the machine (not shown) which causes the head to traverse a path extending over 120 degrees of a circle. Two gages are used continuously upon this work, these being shown at E and F. These two gages are shown on a larger scale in the illustration Fig. 4, where they are indicated as B and C. Gage B is for testing the accuracy of the diameter and radius of the ground race, and consists of a central triangular body from which three hardened and ground steel disks are supported. These disks are ground with knife-edges, and are of proper diameter to coincide with the curve of the race. The gage shown at C in Fig. 4 is used more especially as a check on the size of the radius and consists principally

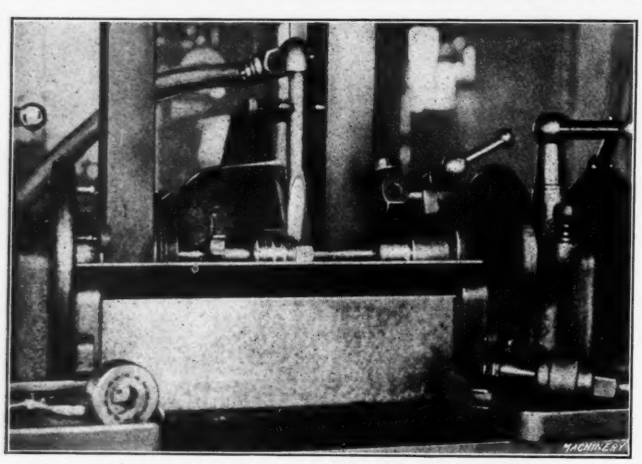

Fig. 17. Finish-grinding the Outside of the Bearing

of a base with two locating lugs and a hardened steel disk similar to those before described, but in this case the disk is mounted on the end of a lever fulcrumed in the body of the gage. Referring again to the gage as shown at F in Fig. 18, which illustrates the other view of the gage, a spring may be seen which tends to keep this disk as far as possible from the locating lugs at the other end. In Fig. 4, the gage is shown in use, and by this means it is possible to see if the race is being ground to the correct radius.

Assembling the Bearing

The parts of the bearing are kept in the proper relation to each other by means of an enclosing shell. This shell, shown in Fig. 13, is of soft sheet steel, and made by a series of ordinary press operations, consisting of cutting and drawing in combination press tools. As it leaves the press, the cup has a bottom at one end and the edges are, of course, straight and more or less irregular. The bottom is therefore punched out, leaving a flange of the proper width to complete this end of the shell. The reverse end is trimmed for a distance that will permit of its being rolled in to form the second flange.

In assembling the bearing, forcing presses are used of the two types shown in Fig. 15. The press in the foreground is a hydraulic press, and the one in the background is operated by a friction drive. A cup is first forced into the shell, after which the cone, a set of balls and a separator are dropped in; then comes the second separator, the second set of balls and the second cup. As the cups fit tightly within the shell, they are forced into their respective places by means of the presses, the second cup being inserted to a point where it just touches the second row of balls.

Rolling the Flange

The rolling-in operation now follows, being done in the machine shown in Fig. 16. The rolling-in operation, or as it is

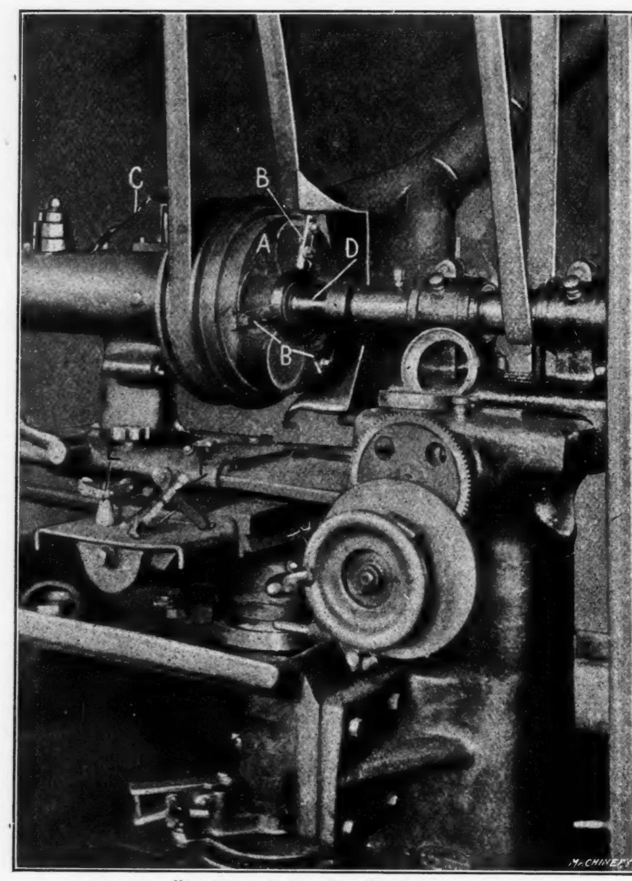

Fig. 18. "Oscillator" Grinding Machine for Cup Races

called, the spinning-over of the shell, is accomplished in three operations, all of which are performed on this machine. Referring to Fig. 16 in connection with the line engraving Fig.

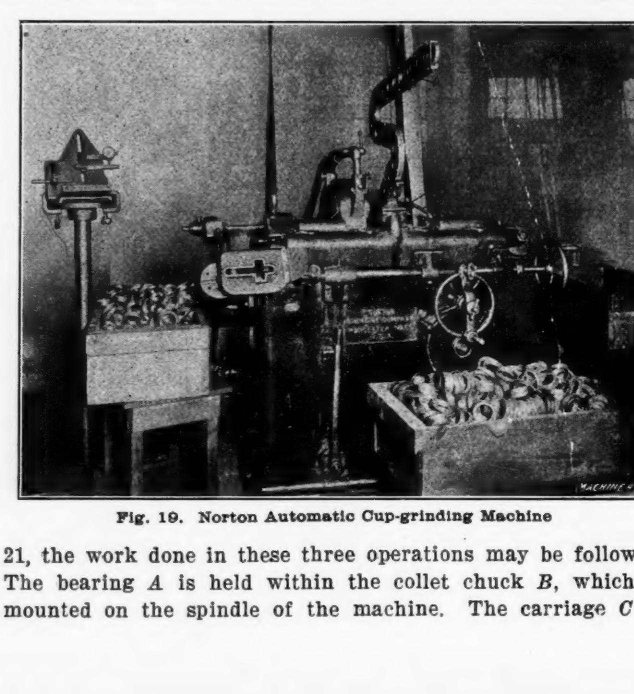

Fig. 19. Norton Automatic Cup-grinding Machine

21, the work done in these three operations may be followed. The bearing A is held within the collet chuck B, which is mounted on the spindle of the machine. The carriage C of

the machine is operated in a lateral direction by handwheel *D*, and in a longitudinal direction by handwheel *E*. Mounted upon this carriage is the rolling fixture *F* which may be swiveled to any one of three positions, being held in any of these positions by means of the index pin *G*, which is lifted by handle *H*. Corresponding index-pin holes are, of course, located in the body of the carriage. A slide *I* operates on this carriage by means of the large handwheel *J*. On the forward end of this slide the roll *K* is mounted. This roll is of hardened steel and has a face approximately 1½ inch wide.

In operation, the carriage is indexed to a position sixty degrees from the center line of the bearing, as shown at *A*

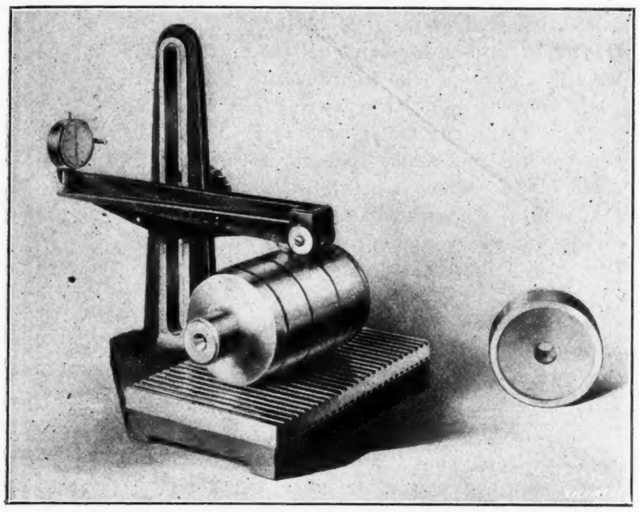

Fig. 20. Testing the Diameter of the Finished Bearing

in Fig. 21, at which position the roll is brought up to the flange, causing it to turn inward to an amount corresponding with this angle. In the meantime, the bearing is being rotated against the roll. The result of this operation is shown at *B* in the line engraving Fig. 21. This being done, the ratchet is indexed to the second position. In this second

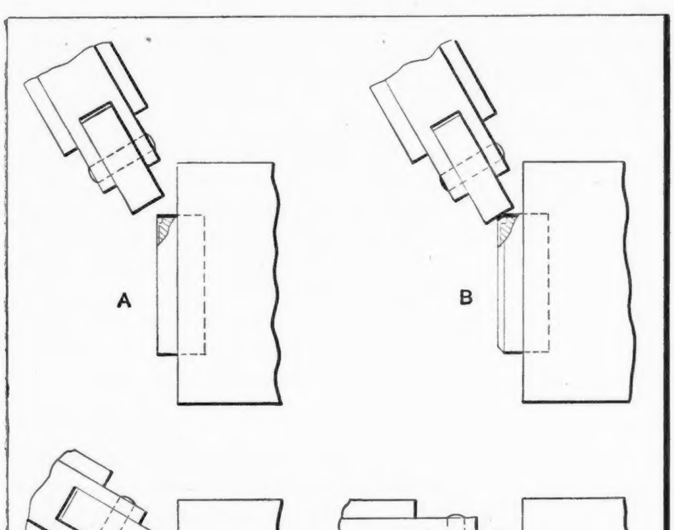

Fig. 21. Steps in Spinning over the Edge of the Shell

position, the slide on the carriage stands at a position of thirty degrees to the center line of the bearing, and, consequently, when the roll is brought into conjunction with the work by means of the large handwheel *J*, the flange of the shell is turned inward a corresponding amount, leaving the bearing and shell in the condition shown at *C* in Fig. 21. As soon as this part of the work is done, the roll is again withdrawn and the carriage swiveled to a position in line with the center line of the bearing, after which the edge of the shell is rolled down into the recess in the outer cup of the bearing, leaving it finished as shown at *D* in Fig. 21. During the three rolling operations, the roll is fed from the outside of the shell inward, by means of lateral feed-screw handle *D*.

Finish-grinding

In order to give the bearing a finished appearance, as well as a truly concentric exterior, it is ground all over after it has been assembled. These grinding operations, which face off the ends and periphery of the bearing, are comparatively simple, the first being performed in ring grinding machines, and the second upon plain grinding machines, as shown in Fig. 17. For this latter grinding operation, the bearing is held upon an arbor having a fixed collar against which the bearing is clamped by means of a washer and nut.

Finish-inspection and Test of the Bearings

Fig. 20 illustrates a gaging fixture used by the inspectors who pass upon the finished bearings. The gage consists of a multiplying lever whose outer end acts upon an Ames gage. A master testing disk is shown at the right, by means of which the reading of the gage is checked from time to time. In the illustration, three bearings are shown under test.

The master measuring machine shown in Fig. 22 is used for miscellaneous inspecting, but more particularly for the checking of the master plugs, disks and ring gages which are examined every day to insure that they are accurate. This

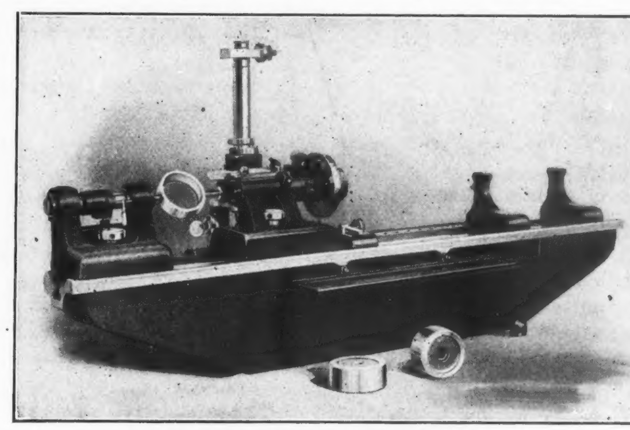

Fig. 22. Master Measuring Machine

machine is fitted with a microscope to facilitate the proper setting of the vernier. In this illustration it is shown with one of the cups between its measuring points.

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LUBRICATION OF MACHINE TOOLS

In an article on machine tool lubrication abstracted from *L'Industria* in the foreign review of the *Journal of the American Society of Mechanical Engineers*, attention is called to the fact that inefficient lubrication in machine tools is the principal cause of the rapid deterioration of this class of machines. It is the minor or secondary working parts, it is stated, which most easily get out of order. The main parts are provided with sufficient and continuous lubrication, while the secondary parts are left to be lubricated by the workman squirting oil through an oil hole from time to time. These oil holes, however, often become clogged with dirt; besides, the lubrication of the minor working mechanisms of the machine is often neglected. This was of little consequence as long as the speeds of machine tools, in general, were low and the power small, but it has become a very important factor under present-day conditions. Some American manufacturers, says the writer, are beginning to design machine tools with automatic lubrication throughout, but this practice is not yet as general as it ought to be.

* * *

RESTORING OVER-EXPOSED BLUEPRINTS

C. J. Kranz of Chicago, Ill., writes that over-exposed blueprints can be restored if immersed in hot water. He has used hot water successfully for restoring blueprints when the white lines were blue and the portions that should normally be blue were steel gray.

DON'TS FOR THE MANAGER*

BY JOHN S. MYERS†‡

Don't discourage suggestions.

Don't tolerate insubordination.

Don't fail to supply pure water for your employes.

Don't build a plant without allowing for expansion.

Don't take credit that belongs to your subordinates.

Don't have favorites, as they seldom respect you for it.

Don't be tight across the chest; penury is not economy.

Don't forget that there are always at least two sides to a story.

Don't be content with mediocre ability—the best is cheapest.

Don't pay men for doing work that can be done on a machine.

Don't allow a clique of men to dominate a plant or a department.

Don't lie to your customers—sooner or later they'll find you out.

Don't buy outside patents and discourage invention in your own men.

Don't compel someone to be a watch-dog—better put in a time-clock.

Don't accept matters of opinion when matters of fact can be shown.

Don't hesitate to scrap a machine when its period of usefulness is past.

Don't permit inaccurate machine work to run up the cost of assembly.

Don't distrust your employes—if they are not to be trusted fire them.

Don't imagine money spent on accurate records is not paying dividends.

Don't forget that a sure way to kill almost anything is to make a joke of it.

Don't be anything but a man and a gentleman if you wish loyal, faithful service.

Don't call down your department heads in the hearing of their subordinates.

Don't permit discord between departments; non-cooperation is a woeful state.

Don't be unreasonable if the men have a grievance; adjust it if possible.

Don't be without proper fire protection or you may soon be without a plant.

Don't get cold feet and shut down in hard times; it breaks up your organization.

Don't believe that system can be run without a little "brain fat" as lubricant.

Don't imagine two fifteen-dollar men are always worth more than one thirty-dollar man.

Don't buy poor materials because they're cheap—they may be expensive in the end.

Don't build things if it's possible to manufacture them—there's a heap of difference.

Don't follow the path of least resistance unless morally certain that it's the correct one.

Don't measure a man's performance by his talk; someone else may be pulling his load.

Don't harass your department heads by undue interference or criticism of trifles.

Don't allow the engineering department to be without a stock-list; make them use it.

Don't expect an undermanned department to get out huge volumes of work on short notice.

Don't get your subordinates all worked up about trifles—it reduces their efficiency.

Don't be curt to a new employe; he probably feels like a cat in a strange garret anyway.

*For Don'ts previously published in MACHINERY, see "Don'ts for Gear Hobbers," April, 1912; "Don'ts for Toolmakers," December, 1911; and "Don'ts for Machinists," February, 1911, with accompanying references.

†The writer is not a manager but has observed that the interesting stories about bees and ants have been written by representatives of another species; he would like to read the story if written by the bees and ants themselves, and, with the idea of "stirring up the insects" has perpetrated these "Don'ts."

‡Address: 2456 Almond St., Philadelphia, Pa.

Don't abolish a thing or method unless you supplant it by something actually superior.

Don't use antiquated methods—of course you think you do not, but do you know it?

Don't address English correspondents as Mr.—they write thusly to their underservants.

Don't imagine anyone, not even yourself, to be infallible, and consequently don't expect it.

Don't make the drafting-room the goat all the time; it's a senseless habit far too prevalent.

Don't have an inadequate system of artificial light or of ventilation—it's poor economy.

Don't advertise spasmodically or semi-occasionally; steady conservative campaigning, is better.

Don't take orders you can't deliver on time or your shipping dates will become a joke in the plant.

Don't tolerate lying or crawling out of it; show that you appreciate frank confession of errors.

Don't engineer a strike in order to break a contract—there are too many unknown possibilities involved.

Don't build a great variety of things varying but slightly from one another—standardize and concentrate.

Don't cast lightly aside the understudy idea; if you don't understand it, visit some plant where they do.

Don't forget that the man on the job probably knows ten times the amount of detail concerning it that you do.

Don't take all your own and your wife's relations into the company's employ—a moderate sprinkling will suffice.

Don't expect to evolve from your inner consciousness all innovations; see what the other fellows are doing.

Don't be without accurate costs, but don't let it cost more to find out what it costs than it does to make the part.

Don't find fault all the time and commend nothing; it's only human to desire a little commendation for extra effort.

Don't give orders direct to the men; it disorganizes the force, and besides, what are you paying your department heads for?

Don't ship a new machine without a thorough tryout; doing so may ruin your reputation in the locality where it lands.

Don't believe that the man who's always running to you with complaints is the man who is earning the most for the company.

Don't forget that things sometimes run "bumpily" instead of smoothly because you, yourself, have strewn the way with boulders.

Don't underrate years of service; it's a mighty poor return for faithful service to fire a man who has become old in your employ.

Don't make your plant an experimental station for a horde of systematizers, but if you need system get the best and get it quick.

Don't look at errors in the aggregate just because *you* hear of all of them. Treat them as percentages per individual; it's more just.

Don't make monkeys of your department heads by needlessly reversing their decisions. It's often best to back them up even when wrong.

Don't be given to snap judgment or arbitrary decisions, especially if at variance with the opinion of an employe who should know.

Don't send cigars to your customers at Christmas, and forget your employes. If the customers knew it they would probably return the cigars.

Don't imagine that any old dub can run the assembly department. There are modern methods and equipment needed here as well as in the machine department.

Don't consider the draftsman an expensive, non-productive, necessary evil; proper design is the first requisite for a money-making output.

Don't disregard instructions for boxing and marking foreign shipments; what is good for U. S. A., doesn't count in some localities.

Don't be afraid to get up designs in advance of orders, for hurry-up designs are generally poor designs, and poor designs are not money-makers.

Don't raise the merry devil about getting a job out quick and then let it lie around the place when done—remember the story of "Wolf, Wolf!"

Don't throw down your representative; by so doing you throw down your own company's pledged word, which is poor policy to say the least.

Don't let it be everyone's duty to fix the belts or oil the shafting, or attend to anything that requires attention; everyone's duty is no one's duty.

Don't make overtime a regular thing—it only pays for emergency jobs; a man's nervous energy is considerably like a bank account, liable to be overdrawn.

Don't have death-traps in the form of unguarded gears, broken railings, unannealed crane chains, weak slings, poorly designed, home-constructed jib cranes, etc.

Don't be a worshipper at the shrine of precedent; if you really have anything good, put it in motion—but don't turn the grindstone backwards just to be different.

Don't surround yourself by incompetents simply because they are friends; loyalty is a jewel, but if coupled with the flaw of incompetency, its value is questionable.

Don't enter orders for a special machine when a little plain talk would show the customer that a standard machine would fill the bill and could be shipped sooner.

Don't forget that it's poor policy to make an employe assign a patent for a dollar; if you pay him a small royalty it encourages the production of still better things.

Don't sell at a loss; abandon a line if it can't be made to pay. (Any boy knows this much but the trouble is that some managers don't know when they are selling at a loss.)

Don't lend but half an ear to the cry for help from your distant representatives; they are on the ground and their troubles are real—put yourself in their place.

Don't be eternally changing department heads; it makes everything unstable, breeds discontent, and each new one is sure to undo much of the good that his predecessor accomplished.

Don't go outside your own organization every time a responsible man is needed; if they're not growing up with you there's something radically wrong with the management, and folks on the outside know it.

Don't leave the stock list to the tender mercies of a twelve-dollar clerk; you have good money tied up in it and good brains should be expended on eliminating all odd sizes, dead wood and remnants of antiquity.

Don't neglect the South American trade; there is a big field open there and when the canal opens it may be bigger. We are the nearest. Why don't we get their trade? It's up to the manager to answer this question. Are you on the job?

Don't let mail to foreign countries be posted without sufficient stamps—the thoughtlessness of your office boy may become an index of your company's methods. In some countries the receiver of such mail has to pay double the amount that is lacking.

Don't hold a man down to a small salary who can make more elsewhere but has private reasons for not wishing to change; it's not a square deal to say "Brown won't leave—he owns his home here," or "George is worth more but he likes the work."

Don't forget that a worth-while man is generally employed, and that to get him you have to pay more than his present employer feels him worth; you are, therefore, counting on the short-sightedness of the other fellow, who is probably playing the same sort of game. You each think you are the sharpest, but he who trains and promotes from his own force does not take part in this foolish competition, neither is he a purveyor of lemons.

* * *

A uniform system for the painting of patterns for steel castings has been adopted at a joint meeting of the Steel Founders' Society and the American Society for Testing Materials. The surfaces to be finished on the casting are to be painted red on the pattern, the rough surfaces are to be painted yellow, and all core prints are to be black.

AIRSHIPS OF THE FUTURE

BY F. E. R.

We were talking about aeroplanes and airships down at the works one noon hour last week. Most of the boys thought the flying machine would be so improved with automatic balancers in a year or two that an aviator could go up in one without feeling that the undertaker was getting the coffin ready for the grease spot he was about to make over in the next township. They said that the heavier-than-air machine was the only practical thing in aircraft, and that the airship was a totally foolish contrivance. You could go up in an airship, but when you were up the wind took you everywhere except to the place you wanted to go. When you tried to land you were likely to knock down a barn or two and muss up the landscape generally. Fritz, the big diemaker, who is American in everything but name and reverence for the Fatherland, listened awhile in silence, but when the airship had been kicked all around the lot, he got mad and surprised us.

"Say, you fellers don't know a thing about airships. You're just like all the rest of the Yankees—think you know it all and that the rest of the world is dead slow. I'll bet you a thousand dollars that Count Zeppelin will sail into New York some fine morning and give them New Yorkers, and the whole country for that matter, something interesting to talk about. Do you know what he has done?"

One of the boys said he knew "Old Zep" had smashed up eight or ten machines, every one worth a barrel of money, and that he would have gone broke long ago if the Kaiser hadn't the war bug so bad he was willing to back anything that could be used to make a bluff with.

"That's just where you are wrong," said Fritz. "The Kaiser is a soldier all right and hot in the war game, but he's a big business man, too. He sees the idea the Count has in his head all right. It's all a matter of size in the airship game—the little ones are no good. The measly gas bag airships you've built over here can hardly lift their own weight, and they're so slimpsey and rickety the wind blows them to pieces when they try to go against it. The Zeppelins are built scientifically with aluminum frames that hold their shape and strong engines that push them where they're steered. They are big—between five-hundred and six-hundred feet long. The bigger they are the more freight and power they can carry, and the stronger they are to stand the wind. You'll see them a thousand feet long—yes, two thousand feet long if you live ten years."

"Say, Fritz, you're crazy," said Frank. "Even if they can be built as big as you say, they wouldn't pay. An idea that can't pan out in dollars and cents won't be carried out. Patriotism is all right, but there's a limit to it. It stands to reason that the Germans are not going to put up a million or two for an airship just to make a holler."

"There's just where you're mistaken again. The bigger the machine the faster it will go, and that's how they'll make money. A hundred and fifty miles an hour is what the Count is working for. Do you see what that means? Twenty-four hours to cross the pond. Say there's any number of rich guys that will pay a thousand dollars to get to Europe in a hurry and they'll pay just as much to get back again; and then, too, there's the mail contracts. Your aeroplanes may be all right to draw the crowds to the country fairs to see lofty tumbling and scrambled remains, but when it comes to doing something worth while in the flying and carrying line, the Count has got you skinned."

And then as the whistle blew I heard Frank mutter: "Maybe 'Old Zep' ain't so crazy after all."

* * *

A company has recently been formed in London, known as the Letters Patent Insurance Co., Ltd., the object of which is to offer insurance of patent rights. The insurance will protect the owner of patents, or other people who are in some way interested in a patent or a patent application, against losses due to legal expenses and infringement suits. It will also insure the cost of such legal procedures as may be necessary to protect a patent from infringement by others.

A BETTER MAGAZINE—A PLEA FOR COOPERATION

BY JOHN S. MYERS*

Am I an editor? No. Then why an editorial from my pen? Because I am a reader who understands that the reader is to a magazine what the common people are to a popular government—he's IT, or should be. Why is the reader IT? Because he is the person for whom the magazine is published. If the magazine appeals to a reader he is likely to interest his friends. This boosts the circulation, and enlarged circulation means more advertisers, hence more income for the magazine to spend on good articles.

Every triangle has three angles and three sides. In an equilateral triangle the three sides, and consequently the three angles, are equal. The conscientious publisher tries to make his enterprise an equilateral triangle, but he can do it only with cooperation. The three sides are the publishers, the readers and the advertisers; the three angles are the viewpoints of these three sides.

Now how can you obtain a better magazine? By cooperating, by making intelligent comments on the articles published, by contributing articles, by joining the staff of educators. Remember that if the magazine is not what you would have it, you are partly to blame.

One way of aiding the contributors to MACHINERY is to write your comments on the margin of the article and send them to the editor or the author. This shows at least that you have read the subject matter and were interested. Your suggestions may bring forth fruit. For example, see the accompanying reproductions of the pages of an article with comments.


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HOW CAN THE MECHANICAL JOURNALS BE MADE OF THE MOST VALUE TO THEIR PATRONS?*

By FRED E. ROGERS†

A scythe is whetted by a stone, but man's intellect is best whetted by contact with other intellects similarly trained and interested. You may be marooned on an intellectual oasis, as far as personal contact is concerned, yet you have freedom of expression and response through the technical press ever at your command. The main trouble is that you do not take advantage of your opportunity. You have a right to renew or discontinue your subscription just as the fancy strikes you, but you do not realize that you also have a right to suggest ways and means for making the magazine what you would have it.

It is a joy and stimulus to a writer to know that his articles have been carefully read. Comment and criticism thereon


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spur him to further effort and put him in touch with his readers' viewpoints. If you cannot write a good article yourself, you can offer intelligent comment in the manner indicated, and will find that such mental exercise is good for you—it will teach you to read appreciatively.

* * *

NEW METHOD OF GALVANIZING IRON

A description of a new method recently patented of galvanizing iron is quoted in the United States *Daily Consular and Trade Reports* from a German publication substantially as follows: To protect iron objects from rust it is customary to coat them with zinc, deposited either electrolytically or by plunging them in a bath of melted zinc. The disadvantage of these methods is that real fusion of the two metals is not obtained, and as a result the zinc coating does not properly protect the iron surface underneath The defect is avoided by the new process which consists in so preparing the iron that the zinc is intimately associated with the surface of the iron, being deposited into its pores. After steeping the parts to be coated in sulphuric acid, they are placed in a solution of mercuric chloride, and then heated, resulting in the decomposition of the mercuric chloride and precipitation of metallic mercury which forms an amalgam on the surface. The iron is then plunged into a zinc bath heated to 500 degrees F., where it remains three minutes. The zinc coating deposited by this method adheres very strongly to the metal. Microscopic investigation shows that the zinc penetrates into the pores of the iron, and in case a portion of the coating is worn or peeled off, the iron does not rust owing to the presence of sufficient zinc in the surface to protect the metal from the action of the atmosphere. In other words, there is a perfect alloy or association of the two metals at the point of juncture.

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HEAT TRANSMISSION THROUGH BUILDING WALLS

In considering the rate of transmission of heat through building materials, considerable uncertainty exists in regard to the accuracy of the results obtained, on account of varying conditions of wind and weather, leakage, exposure, and a number of other causes. The problem becomes especially puzzling when the engineer is called upon to deal with materials of construction with which his profession has not had experience.

The modern tendency to construct shops and manufacturing establishments with large window areas—where the concrete or steel frame frequently forms little more than a grid—has directed considerable attention to the calculation of the heating requirements of such buildings. The Green Fuel Economizer Co., Matteawan, N. Y., has recently installed hot-blast heating equipments in a number of concrete and glass buildings, and also in buildings covered with sheet metal. This installation recently afforded an opportunity to ascertain the transmission of heat through one of the sheet-metal buildings last referred to. This shop has a continuous window space on one side 15 feet high and on the opposite side 19 feet high. The walls of the building consist of corrugated iron of single thickness and without lining. The crevices at the eaves are filled with asbestos, the corrugated iron is cemented in at the bottom, and other precautions have been taken to make the building as nearly air-tight as possible. The exposure of the windows is east and west, the smaller windows being on the east side.

The coefficients given by different authorities for the rate of heat transmission through single windows vary somewhat. Prof. Homer Woodbridge gives this coefficient for single windows with a southern exposure as 1 B. T. U. per square foot per hour, per degree difference between the inside and outside temperatures. This figure is increased 35 per cent for northern exposures, 25 per cent for western exposures, and 15 per cent for eastern exposures. The only available figure for corrugated iron without sheathing is the one determined by Rietschel, which is 2.132, but no statement is given as to whether it refers to superficial wall area or to the actual surface of the iron.

In the case of the building under discussion, the total surface is made up of approximately 7538 square feet of window space which includes the sash, 8247 square feet of wall space, and 11,925 square feet of roof. The surfaces of both walls and roof are given in superficial area, and in order to account for the corrugation in the iron, this value must be multiplied by a factor of 1.35. This gives the total area of the walls and roof as $20,172 \times 1.35 = 27,232$ square feet.

The building is heated by a Green hot-blast heater with the assistance of an engine-driven centrifugal fan drawing through a "Positiv-flo" heater made up of six sections of four rows of piping. The sections measure 7 by 8 feet. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. There are altogether 6816 lineal feet of one-inch pipe in the heater, which is equal to 2272 square feet of heating surface. The air is distributed throughout the shop by circular sheet-iron conduits with their outlets directed down into the zone occupied by the workmen.

The temperature of the building was maintained constant during the test which covered a period of three hours. The fan was run at 258 R. P. M., and received 22,416 cubic feet of air per minute, figured at a temperature of 50 degrees F; this air was actually received by the heater at a temperature of 73 degrees F., and delivered from the fan at 156 degrees F. The temperature of the steam in the heater was 212 degrees F, and the temperature of the air delivered from the furthest outlet was 141.5 degrees F. Under these conditions the temperature of the building, measured at a distance of three feet from the floor, was found to be 66 degrees F., and measured in the gallery, the temperature was 70 degrees F.; the temperature outside the building at the time of the test was 15 degrees F.

Two methods were employed for the determination of the total heat supplied. The first method consisted in calculating the heat from the rise in temperature of the air passed through the heater. By the second method, the heat was calculated from the condensation taking place in the heater. For the latter purpose the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B. T. U. per hour, and by the condensate method 2,029,730 B. T. U. per hour. Using these figures, it appears that the average rate of heat transmission through the superficial area of the building was 1.42 B. T. U. per square foot, per hour, per degree difference in temperature, and using the value obtained by the steam method, the value of coefficient is 1.38 B. T. U. per square foot, per hour, per degree difference in temperature.

Taking Prof. Woodbridge's figures for the rate of heat transmission through the windows, we would get 1 B. T. U. per square foot, per hour, per degree difference in temperature as the coefficient for a southern exposure. This value must be increased by 15 per cent for an eastern exposure, and 25 per cent for a western exposure, or an average value of approximately 20 per cent for the present case; this gives the value of 1.2 as the coefficient for the window surface. The value of the coefficient for the corrugated iron, merely figuring the superficial area, is 1.5. Figuring the entire surface of the iron gives the value of the coefficient as 1.13, which is less than an equivalent amount of glass surface. This result seems hardly correct, although it may be so, the explanation being that the corrugations in the iron protect the surface to a certain extent, thus making the heat transmitted from a square foot of corrugated iron less than it would be from an equal surface of flat metal.

Allowing for many indeterminate conditions, it would probably be safe in calculating the heat supply for buildings of this kind to provide for a coefficient of transmission of 2 B. T. U., per square foot, per hour, per degree difference in temperature for the whole wall and roof area.

* * *

TURNING LEFT SHOE LASTS FROM RIGHT MODELS

The conception of the average layman of the state of the material universe if the much-discussed "fourth dimension" of the mathematicians could be perceived, is the possibility of a solid body disappearing from the view of ordinary mortals into fourth-dimensional space; of turning spheres inside out without rupture; of converting right-hand gloves into left-hand gloves without turning them wrong side out, and so on. Whether or not the fourth dimension is merely a mathematical figment we may never know, but a practical and startling illustration of producing right forms from left forms can be seen any day in shoe-last turning shops. Most mechanics are more or less familiar with the general principle of the Blanchard lathe for turning axe handles, gun stocks, hat blocks, shoe lasts, etc. The general impression is that an exact model of the piece to be turned is rotated in unison with the work and a guide wheel pressing against the model transmits the necessary radial motion to the cutter to produce the shape desired. But in the case of "rights" and "lefts" one model will serve for both shapes. A right shoe-last model is used for turning a left last, the model and work being run in opposite directions and one-half revolution apart; the sole of one is up while the other is down, and so on. Thus, in a sense, the fourth dimension possibility is actually realized.

* * *

The Department of the Interior, Bureau of Mines, has issued a bulletin (No. 47) on mineral waste in the industries, which gives a startling statement of the loss of zinc in the Waterbury, Conn., mills. It is estimated that 7500 pounds of zinc passes into the atmosphere daily in the form of zinc oxide. Zinc boils at 930 degrees F. and the present melting practice does not prevent the loss of the vapors. The solution of the problem of eliminating these losses is some form of closed furnace, of which the electric furnace is a prominent type and perhaps the only practicable form now known.

SAFEGUARDS FOR POWER PRESSES*

A NUMBER OF EFFECTIVE SAFETY DEVICES ADOPTED BY LEADING MANUFACTURERS

BY EDWARD K. HAMMOND

The problem of providing for the safety of power-press operators presents two possibilities of solution. The first alternative is to use presses equipped with some form of automatic feeding device that makes it unnecessary for the operator to put his fingers under the ram. The second is to adopt some form of safeguard that keeps his hands away from the die during the working stroke of the ram.

The different forms of automatic feeding devices which have been successfully applied in power-press work were fully discussed in articles published in MACHINERY October, 1911, and January, 1912. Owing to the fact that automatic feeding removes the necessity for the operator to put his hands under the ram, presses equipped with such feeding devices are as safe as they can be made for handling the class of work required of them. These devices do not reduce the operator's output, and the only argument against them is that the first cost of presses equipped with automatic feeding devices is higher.

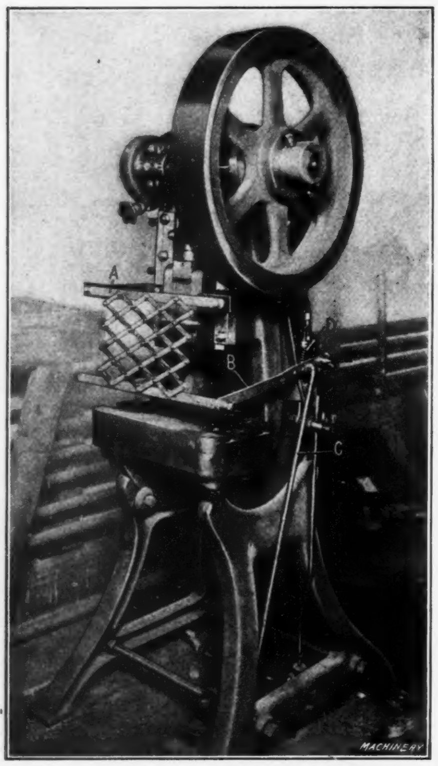


Fig. 1. The Cream City Accident Preventer made by Geuder, Paeschke, & Frey Co.

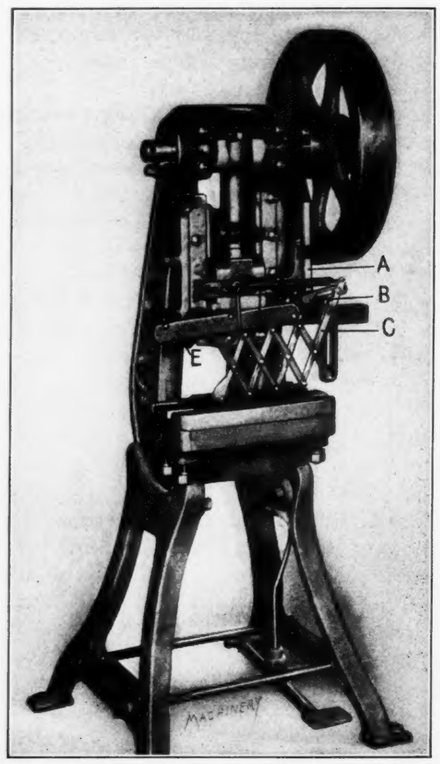


Fig. 2. Safeguard with Pantograph Gate which expands from Side

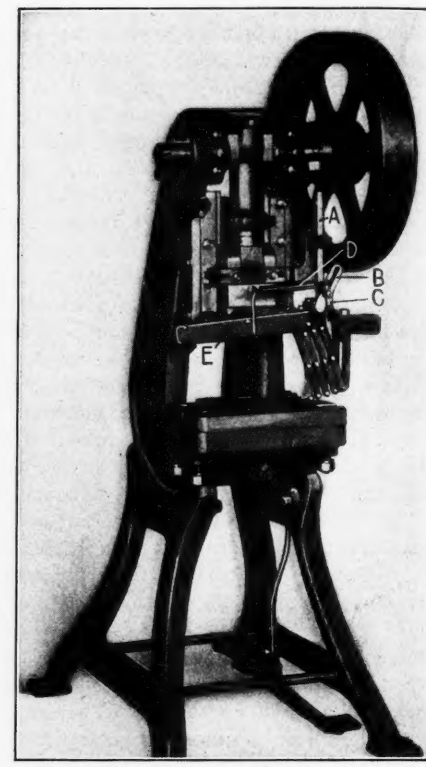


Fig. 3. Same Press as in Fig. 2, with Guard folded to One Side

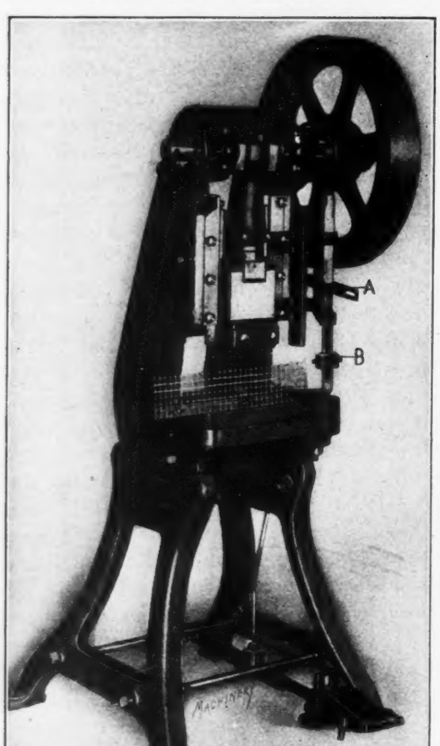


Fig. 4. The Jones Stamping Press Guard; Ram Descending

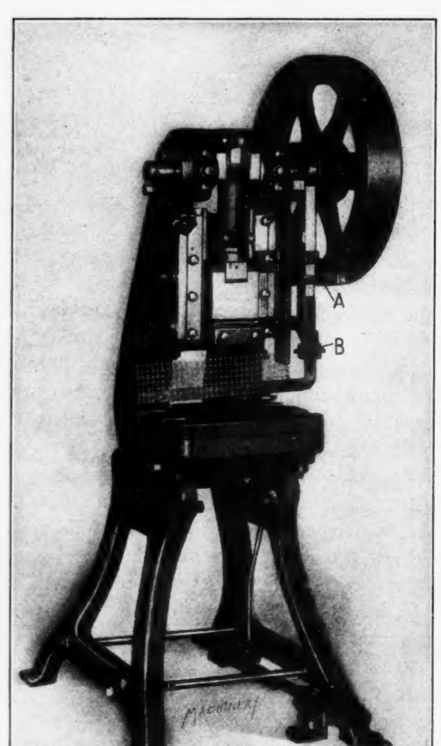


Fig. 5. The Jones Press Guard in Position before Treadle is tripped

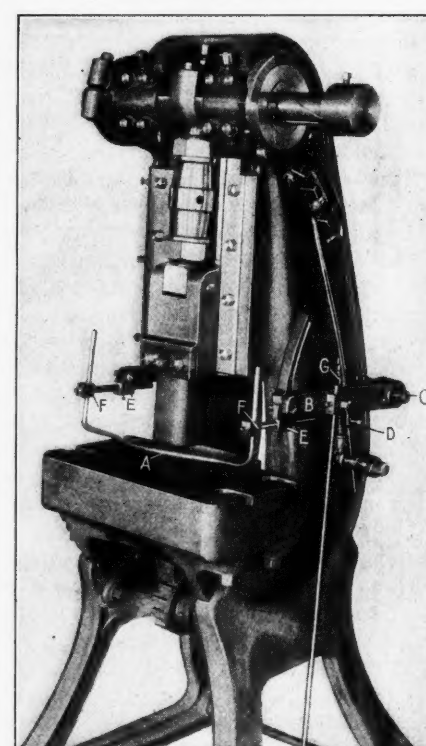


Fig. 6. Safeguard using a Bar instead of Gates

* For further information relating to the safeguarding of machinery and the prevention of accidents in shops and factories, see "Prevention of Industrial Accidents," MACHINERY, engineering edition, April, 1912, and "The Prevention of Industrial Accidents," in the engineering edition, November, 1911. See also the list of previously published matter referred to in connection with the article last mentioned.

In this article, different forms of power-press safeguards which have found successful application in well-known manufacturing plants, will be described. An important advantage in favor of their application lies in the fact that they can be used on the presses which a shop already has in operation, thus providing for the safety of the operator at a relatively small expense. Among the different types, one can almost always be found which will meet the requirements of any one class of power-press work.

The advisability of adopting every precaution to provide for the operator's safety offers little ground for discussion. Aside from humanitarian considerations, which constitute a sufficient reason, safeguards are well worth while when considered from a purely economic standpoint. The premiums charged for accident insurance for operators of power presses average about eight times the rates for operators of other classes of metal working machinery. Well designed safeguards reduce the risk involved and enable a considerable saving to be made in the cost of accident insurance.

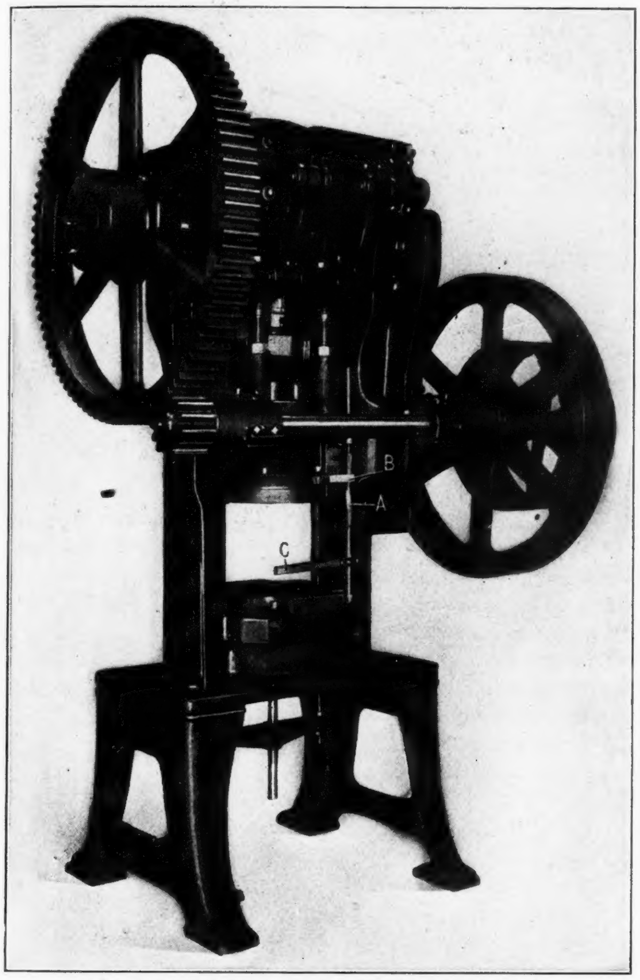


Fig. 7. Guard Bar swung over Die by a Twisted Rod

The Cream City Accident Preventer

The safeguard illustrated in Fig. 1 is manufactured by the Geuder, Paeschke & Frey Co., Milwaukee, Wis. In the manufacture of tinware and sheet steel ware, this company experienced great trouble from the injury of power press operators, and as the result of study given to the subject, the guard shown in Fig. 1 was developed. The original idea was merely to avoid power press accidents in the company's shops, but the guard was found to give such satisfaction that it was decided to place it upon the market. It is known as the "Cream City accident preventer," the first two words corresponding with the names of this company's other products.

The guard consists of an expanding gate, of the pantograph type, which opens before each down-stroke of the ram, thus blocking the approach to the die. It is attached to the press by means of two brackets *A*, which are secured to the press by means of the regular gib screws. The method of operation is entirely automatic. A lever *B* is fulcrumed to the side of the press where the driving clutch is located, and is connected with the treadle by means of rod *C*. When the treadle is tripped, this rod pulls down the lever, which, in its turn, expands the gate in advance of the descent of the ram. The guard is arranged in such a manner that the gate must be all the way down before the clutch can be engaged. This makes it necessary for the operator to remove his hands from the work before the press can be tripped, and should he attempt to adjust the position of a blank at the last moment—which has been one of the most frequent causes of accidents on unguarded presses—the descent of the gate is checked, thus preventing the engagement of the clutch and the downstroke of the ram. When the treadle is released, the tension of spring *D* causes the gate to return instantly to the folded position, so that it is out of the way for the next operation.

At the place where lever *B* is pivoted to the frame of the press, a screw *E* is provided, which enables the point to which the gate must descend before the clutch is engaged to be adjusted. For most classes of work, this screw is set to bring the gate to within at least 1/8 inch of the table before the clutch is engaged. Such a setting, however, would interfere with sheets that extend out in front of the press, and for such classes of work the gate is set to descend to a point just above the level of the die before the engagement of the clutch can be effected. In such cases, the bottom of the gate is practically in contact with the face of the work; consequently, the same degree of protection for the operator is secured.

The application of this guard does not require the construction of the press to be altered in any way, the only work necessary being that of drilling and tapping holes for the bolts which secure the operating lever *B* to the frame of the machine. The openings in the guard gate enable the operator to have his work in plain view at all times.

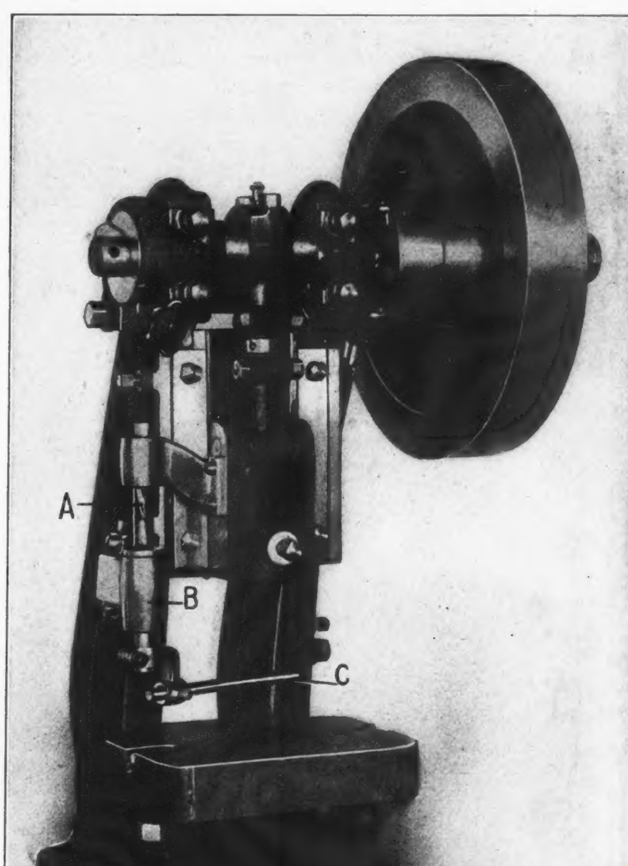


Fig. 8. Guard Bar swung over Die by Pin in Spiral Groove

A somewhat similar, although less efficient guard than the one just described, is shown in Figs. 2 and 3. In this case the pantograph gate expands from the side, its movement being controlled by the bar *A*. As the slide descends, this bar, which is attached to it, engages a cam carried by the pivot

on which lever B is mounted. This swings lever B down into a nearly horizontal position, as shown in Fig. 2, and expands the pantograph gate across the front of the die, through the leverage exerted by the extended arm C of the gate. The action of the mechanism is so timed that the gate shuts off

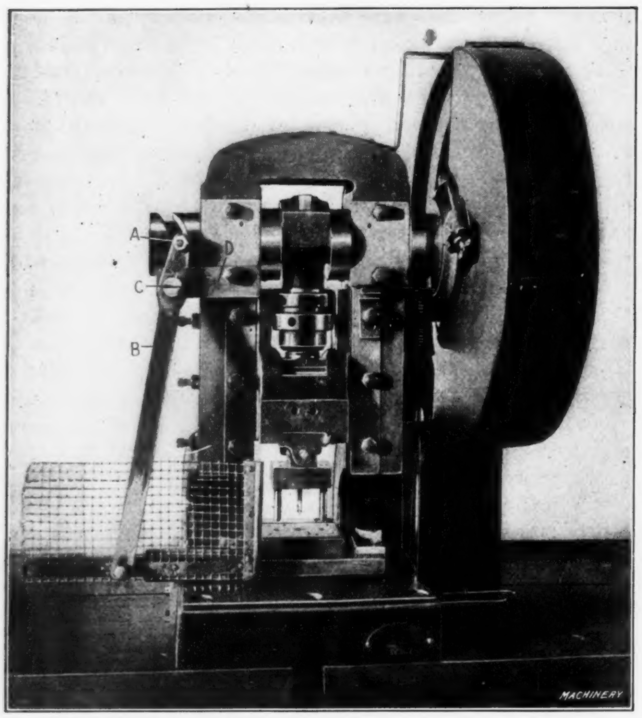


Fig. 9. Safeguard with Gate which swings from the Side

access to the die before the punch has descended upon it. When the ram rises, bar A is carried up with it. This releases the mechanism, and the gate is closed by the tension of spring D; E is simply a guide in which the gate travels.

The Jones Stamping Press Guard

The press illustrated in Figs. 4 and 5 is equipped with a safety device known as the Jones stamping press guard,

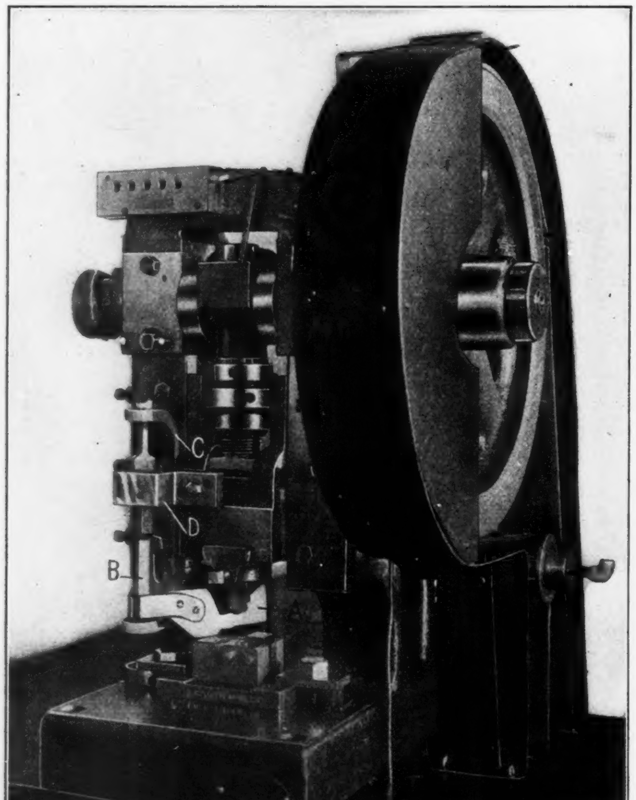


Fig. 11. Guard which sweeps over Die before Ram descends

which is manufactured by the Jones Safety Device Co., Chicago, Ill. When in operation, the wire-mesh gate drops somewhat ahead of the down-stroke of the ram, thus barring the operator's access to the die during the working stroke. The design is such that the gate must reach the bottom of its stroke, which brings it into contact with the table, before the clutch can be engaged.

The operation of the guard is controlled by lever A, which is pivoted to the frame of the press. Connection is made

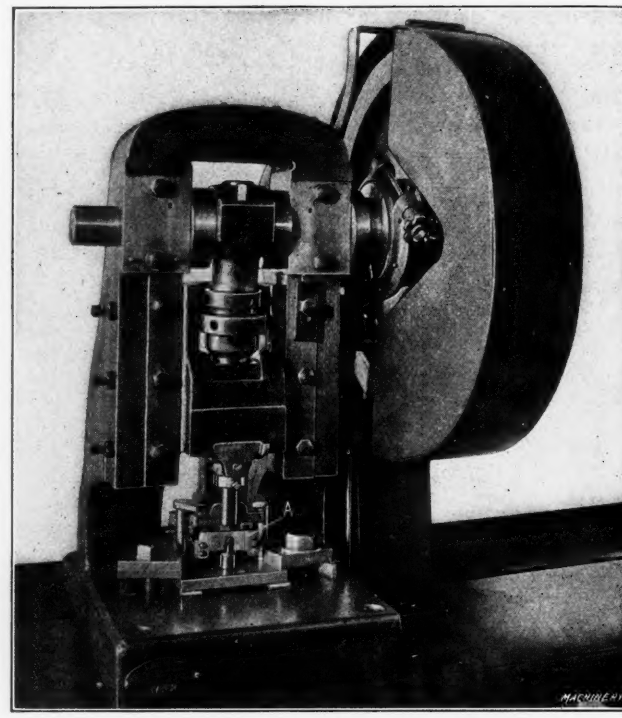


Fig. 10. Guard with a Plate operated by Cam attached to the Ram

between the treadle and the clutch by means of two rods which are secured to this lever by adjustable clips. When the guard is to be applied to an inclinable press, the treadle rod is in two sections, which are threaded at their ends to carry an adjusting clip, so that the length of the rod can be varied as required.

When the treadle is pushed down to trip the press, lever A

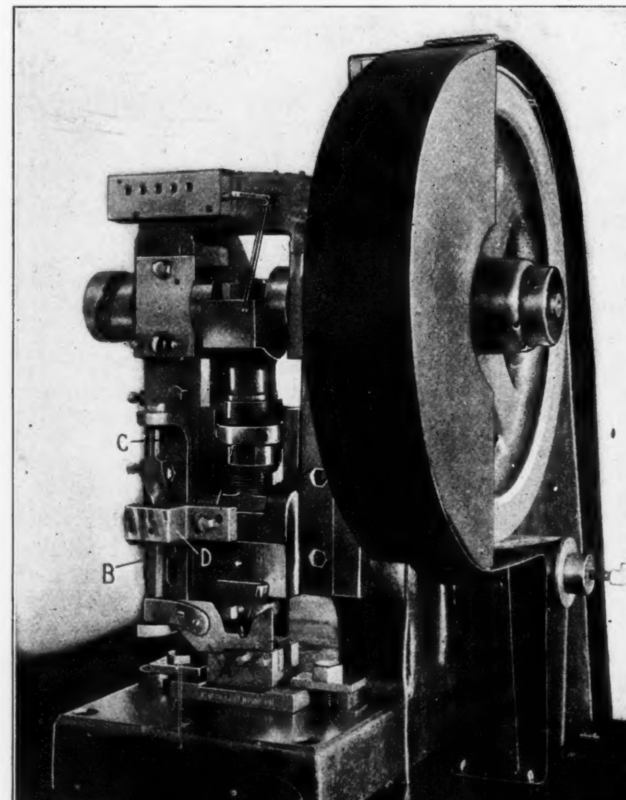


Fig. 12. Same Guard as in Fig. 11, in Position in Front of Die

carries the gate down to the table. If the operator fails to remove his hand from the die, the descent of the gate is blocked and this prevents the press from operating, because the clutch cannot be engaged until the gate has reached the

bottom of its stroke. After the ram has completed its working stroke and started to rise, the gate is immediately lifted by the action of a spring which connects the rear end of lever *A* and the frame of the press. If it is more convenient, this spring can be attached between the treadle and the frame of the machine. The instantaneous action of this spring prevents the output from being reduced, as the guard is out of the way as soon as the ram has risen sufficiently to enable the operator to begin preparing for another operation.

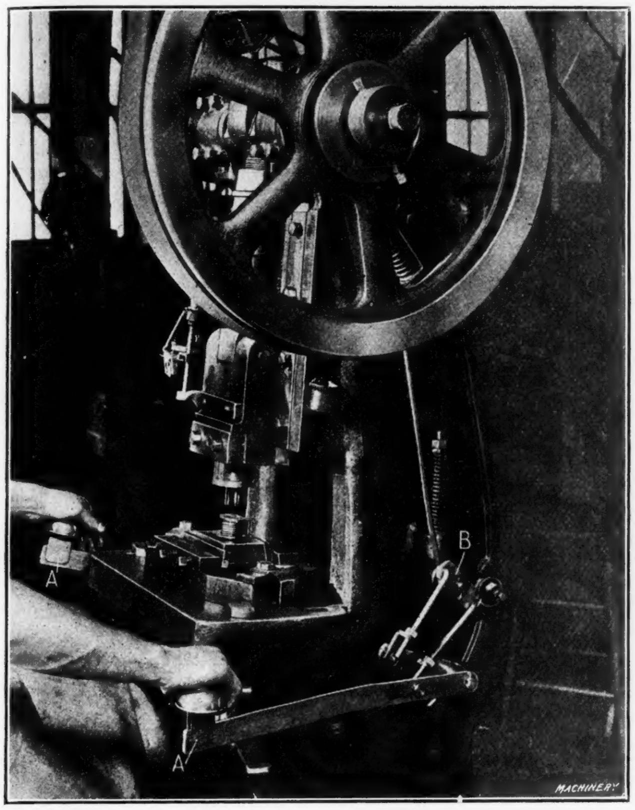


Fig. 13. Arrangement of the Benjamin Stamping Press Guard

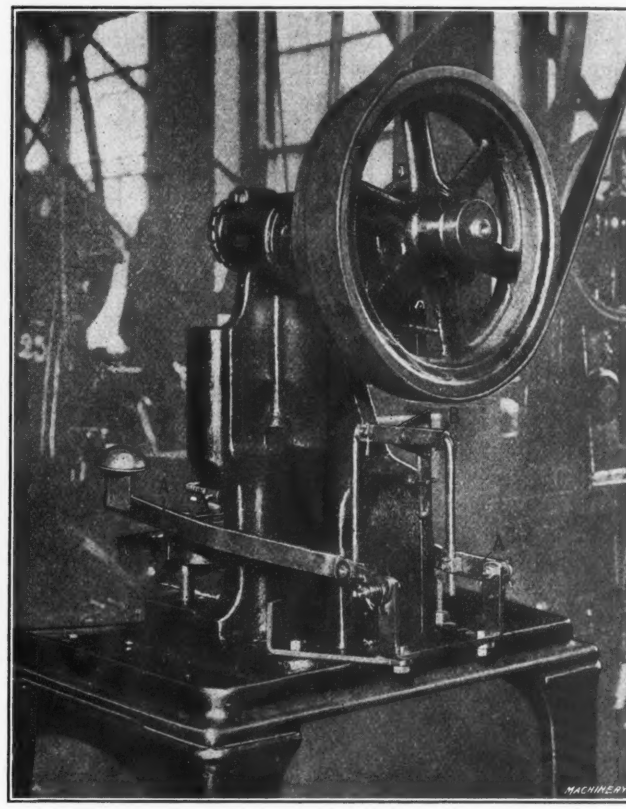


Fig. 14. Another Arrangement of the Benjamin Guard

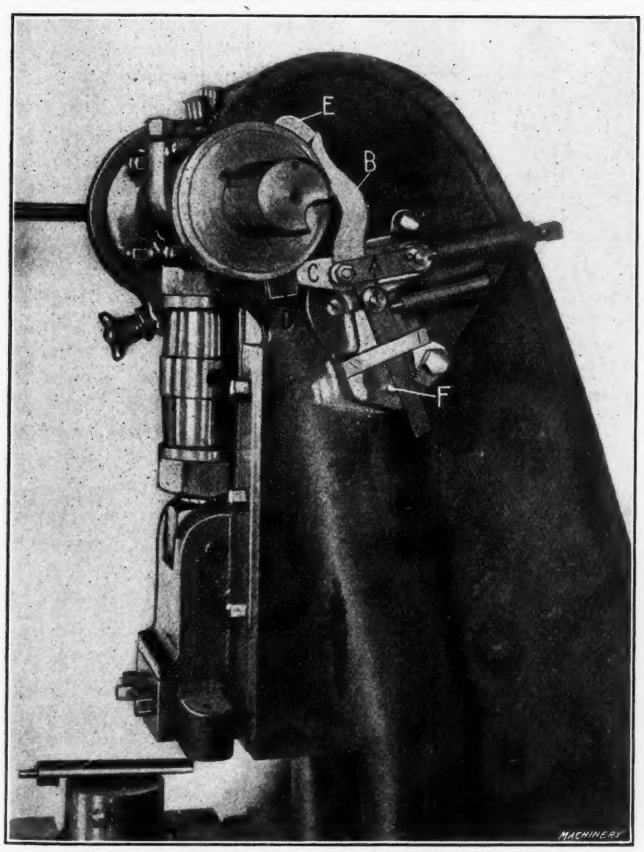


Fig. 15. Mechanism of the Bliss Automatic Safety Clutch

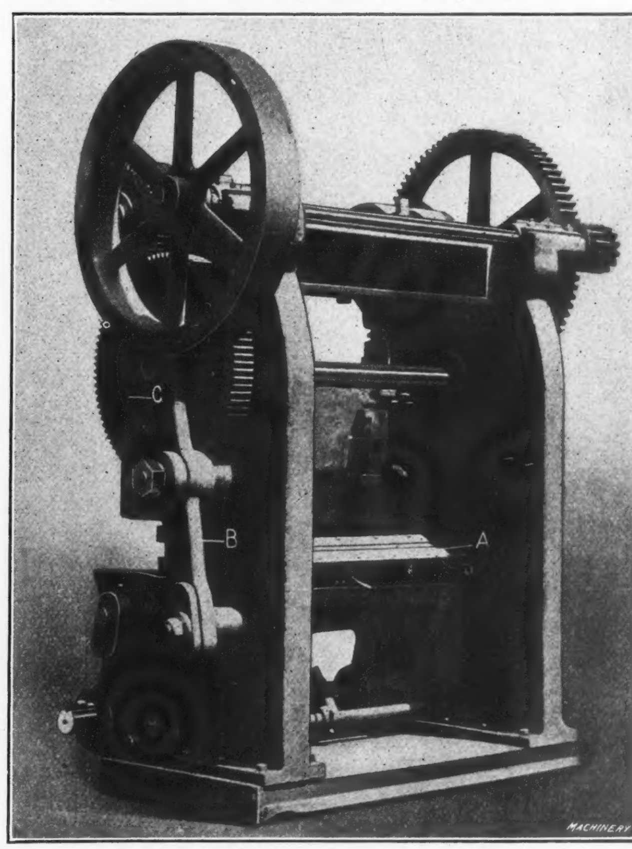


Fig. 16. The Improved Queen City Safety Press

Clip *B*, which secures the gate bar to lever *A*, enables the position of the guard to be adjusted to meet the requirements of different classes of work and dies. The gate should always be set to a point where it touches the table before the clutch can be engaged. This guard is easily attached to the press on which it is to be used. The only work entailed consists of drilling and tapping holes in the frame to secure the operating mechanism in place. In some cases, the wire mesh gate has been replaced by a flat rod, covered with leather, somewhat similar in shape to the one upon which the wire netting is mounted. The object of this modification is to allow the operator an unobstructed view of his work during the entire working period of the press.

In Fig. 6 a power press guard is illustrated which works on much the same principle that governs the operation of the ones shown in Figs. 1, 4 and 5. In this case, the guard bar *A* has been adopted in place of the gates used in the two other

devices referred to. When an operator is working at a press equipped with one of these guards, his hands are beneath the bar *A* and this bar must drop to the die bed before the clutch can be engaged. This makes it impossible for the operator to trip the press and forget to remove his hands from the die, because, under these conditions, bar *A* cannot fall far enough to allow the clutch to be engaged.

The operation of this guard is controlled by lever *B* which is pivoted to the frame of the press at *C*. When the treadle is depressed, this lever carries the guard bar down with it. After the guard has practically reached the die bed, lever *B* engages the stop *D* on the clutch rod and pushes it down sufficiently to throw the clutch into action.

It will be seen from the illustration that the position of the guard rod can be adjusted horizontally at *E* and vertically at *F*, and that the stop *D* on the clutch rod may be adjusted to correspond with different settings at *F*. This enables the guard to be adapted to different classes of work. The stop *D* should, in all cases, be set so that the clutch cannot be engaged until the guard rod is almost in contact with the die bed.

After the press has been tripped, spring *G* throws the guard up as soon as the ram has begun its return stroke, so that the operator is not delayed in any way. This type of guard can be applied to any type of press without altering its construction, by simply drilling and tapping the holes in the frame of the machine necessary for securing the guard in place.

The two guards shown in Figs. 7 and 8 work on essentially the same principle. When the ram of the machine shown in Fig. 7 begins its down-stroke, the vertical rod *A* is rotated by means of the twisted section which runs through a bearing

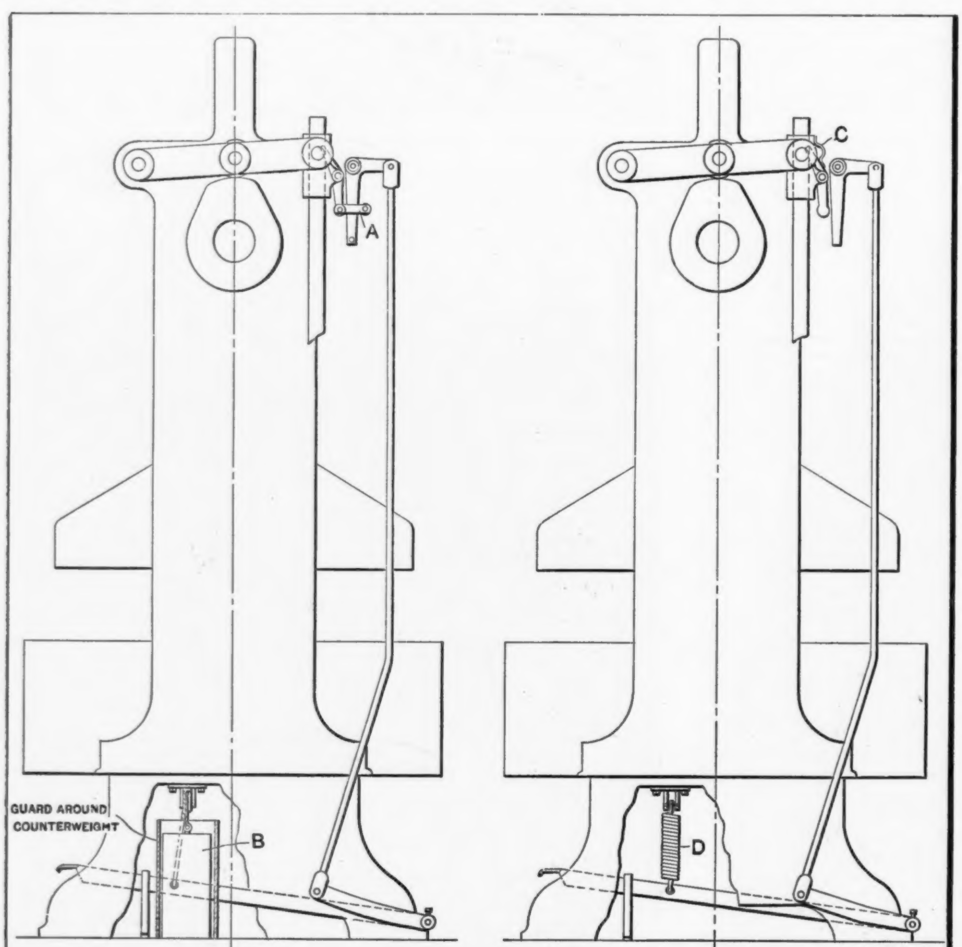


Fig. 17. A Modification of Design, replacing Springs by a Link and Weight

in *B*. This causes bar *C* to swing over the die, and in case the operator has neglected to remove his hands, they are struck by this bar, thus warning him of his danger. Bar *C* moves considerably before the ram has reached the bottom of its stroke, so that the operator is given plenty of time to get his hands out of danger if he has neglected to do so at the time of tripping the press.

The action of the guard shown in Fig. 8 is similar to that of the one just described, but in this case the round rod *A*, with a spiral groove cut in it, has been substituted for the twisted square rod shown in the preceding illustration. The groove in this rod is engaged by a pin in bearing *B*, thus swinging the guard bar *C* as previously described.

Guards used in the General Electric Co.'s Shops

The guard illustrated in Fig. 9 was developed by the General Electric Co., for use in its power-press shops. When

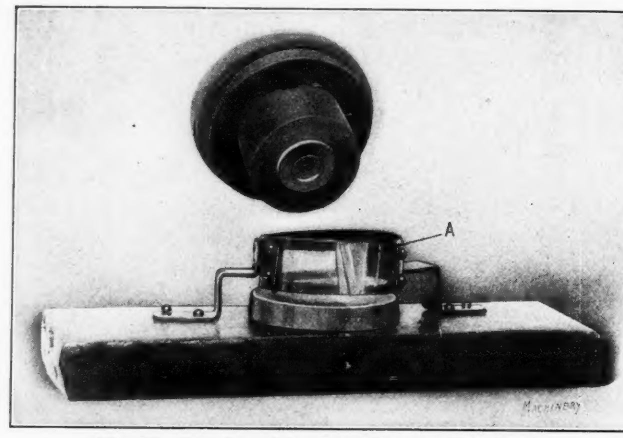


Fig. 18. Guard used for Operations on Thin Stock

the operator sets the press in motion, the pin which runs in slot *A* swings lever *B* about pivot *C*. The shape of slot *A* is such that lever *B* carries the gate to the right a little ahead of the down-stroke of the ram. This shuts off access to the die during the working stroke of the press; should the operator fail to remove his hands from the work at the time of tripping the slide, he is warned of his danger by the movement of the guard. The gate runs on a guide on the die bed. The guard is secured to the press by bracket *D*, which carries the pivot *C*. This bracket is secured by one of the gib screws and a couple of small pins which prevent it from rotating.

Fig. 10 illustrates another form of power press guard which has been used in the shops of the General Electric Co. In this case, the guard plate *A* comes forward, ahead of the down-stroke of the ram, and pushes the operator's hands away from the die. The movement of the guard plate is controlled by a cam attached to the rear of the slide. When the working stroke has been completed and the slide commences its upward travel, this cam releases the guard and allows it to be returned to the rear of the die by the tension of a spring.

The guard illustrated in Figs. 11 and 12 has been adopted by the General Electric Co. to supersede the equipment shown in the preceding illustration. In this case, guard plate *A* swings on rod *B*, passing over the die far enough ahead of the ram to give the operator ample time to get his hands out of danger if he has neglected to do so at the proper time. The guard is attached to the press by means of bracket *C*, which is held in place by means of the regular gib screws. Rod *B* is a loose fit in this bracket, so that it is easily rotated by the action of *D* upon the twisted section of the rod.

When a press is engaged in stamping out parts from thin sheets, a guard of the type shown in Fig. 18 can be used to good advantage. In using a press equipped in this way, the

operator slips the stock under guard *A*. The space between the bottom of this guard and the die is just sufficient to admit the stock, but will not permit the operator's fingers to get within reach of danger. The General Electric Co. uses guards of this type on presses for stamping mica insulations; they would prove equally serviceable on other classes of work where thin stock is being handled.

The Benjamin Stamping Press Guard

The stamping presses illustrated in Figs. 13 and 14 are equipped with a safeguard which has been designed and placed upon the market by the Benjamin Electric Mfg. Co., Chicago, Ill. This device was first developed to meet the requirements of the Benjamin shops, but proved to be so satisfactory that it has recently been placed upon the market. It is not intended for presses used for blanking from strips or ribbon stock, and when presses are used alternately for such operations and for stamping, the guard may be easily disconnected, and the regular treadle used. This change does not involve any particular risk, as blanking operations on ribbon stock do not require the operator to work with his fingers under the ram.

As shown in the illustration, the guard consists of two hand levers *A*, one at each side of the press. These levers connect with the equalizer *B* which is mounted on the clutch rod. This equalizer swings about a pivot at its center, so that pushing down only one of the hand levers does not have any effect upon the clutch. Both levers must be pushed down to trip the press, and as both hands are required for this purpose, the operator cannot get his fingers caught. The release of either lever allows the latch to return to its normal position, thus making it impossible for the press to repeat unless both levers are kept down until the second stroke has been started. In this case, the operator would not have time to get his hand under the ram before its downward travel was completed. Different arrangements of this guard have been worked out to adapt it for use on all standard forms of presses, two such arrangements being shown in the illustrations.

Experience has shown that it is poor policy to depend upon the tension of a spring to control the operation of any mechanism, the failure of which may inflict a serious injury upon the operator. The tension of a spring weakens with age, and may become inadequate for the service which is required of it.

Fig. 17 illustrates a power press that was originally equipped with the springs *C* and *D*, as shown at the right-hand side of the engraving. The danger of relying upon these springs to control the clutch was realized, and the design of the press was modified, as shown at the left-hand side of the illustration. Here link *A* and counterweight *B* have replaced the springs, so that there is no possibility of failure due to an inadequate tension, as the clutch is now controlled by the constant force of gravity.

The Bliss Safety Clutch

A large majority of power-press accidents are caused by the failure of the operator to remove his foot from the treadle after completing an operation. In such cases, the wheel is kept locked to the shaft and causes the ram to descend a second time when the operator is not expecting it. To avoid such accidents, the E. W. Bliss Co., Brooklyn, N. Y., and several other well-known builders of power presses, have designed clutches which require the treadle to first be released and then pushed down again in order to cause the ram to descend for the next operation.

Fig. 15 shows the Bliss safety clutch, which operates in accordance with this principle. When the treadle is pushed down, latch *C* is lowered by means of trip-hook *B*, thus allowing the end of the clutch-key *D* to spring out and throw the clutch proper into position to engage with the flywheel. The shaft now revolves, bringing trip-dog *E* against trip-hook *B*, disengaging it and breaking the connection between latch *C* and the treadle rod that connects at *A*. This allows the latch to spring up and throw the clutch out of action.

When the foot is removed from the treadle, trip-hook *B* re-engages with latch *C*, and the mechanism is ready to be tripped for the next operation. The press may be run continuously by sliding the trip-hook *B* ahead of the spring-pin *F*. In this position, the trip-dog does not strike against the hook, and no break is made between the treadle and the clutch. Consequently, the slide continues to operate as long as the treadle is kept down. The E. W. Bliss Co. is now putting these clutches on all of its presses.

The Improved Queen City Safety Press

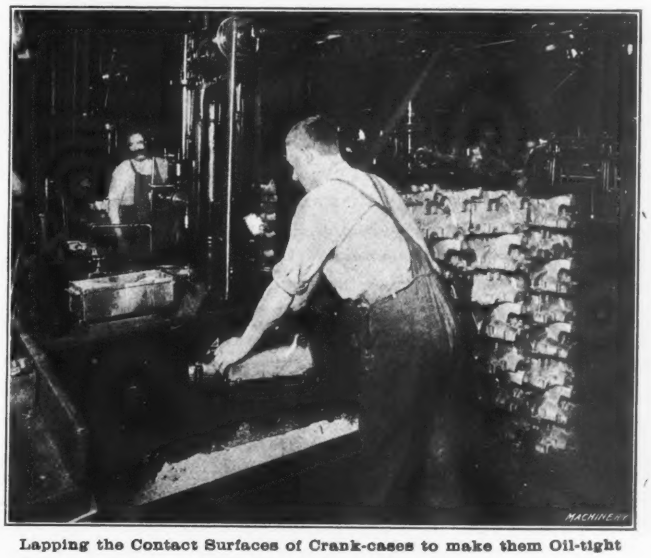
The press illustrated in Fig. 16 is built by the Queen City Punch & Shear Co., Cincinnati, O., and has been designed along lines which provide for the operators' safety. The oscillating table *A* swings out from under the ram to permit the removal of finished work and the substitution of new blanks. Hence the operator does not need to put his hands under the ram. The oscillation of the table is controlled by means of rocker arm *B* and cam *C*. The machine shown in the illustration is equipped with a double set of dies and requires two men to operate it, one standing at the front and the other at the rear. After the working stroke, the die bed in which the work has been formed or pressed remains stationary until the ram is partly raised. It then moves forward to the operator and remains at rest long enough to give him ample time to remove the finished work from the dies and replace it with new blanks. During this time, the other die bed is under the ram, a working stroke of the press being made. The die beds thus receive alternate strokes of the press, allowing plenty of time for the operators to perform their work, while the dies are swung out away from the danger zone beneath the ram. Machines of this type are also built with a single die bed and only require one operator to run them.

* * *

LAPPING CRANK-CASES

In the best types of automobile engines, all the vital parts, such as the transmission gears, etc., are enclosed in cases to protect them from dust and dirt. Another point which is just as important as protection from dirt is proper lubrication. In some engines this is accomplished by filling the cases with lubricating oil, which, of course, necessitates that they be oil-tight.

Instead of using packing between the surfaces of the crank- and transmission-cases that come in contact, the White Co.,



Lapping the Contact Surfaces of Crank-cases to make them Oil-tight

Cleveland, Ohio laps all the contact surfaces. This operation is accomplished as shown in the accompanying illustration. A large surface plate is coated with oil and emery, and the cases, after having their contact surfaces milled, are moved back and forth on this plate until a true surface is obtained. This method makes an oil-tight fit which is superior to shims or packing. D. T. H.

* * *

Switzerland, the area of which equals about one-third of that of Pennsylvania, has about 2800 miles of railway, of which 103 miles or about 3.7 per cent of the total is in tunnels. No less than nine of these are more than five miles long, the total number of tunnels being 415.

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DEVELOPING MACHINE TOOLS TO MEET MANUFACTURING CONDITIONS

A well-known machine tool builder, whose product is of a specialized nature, has consistently followed a practice during the past five or six years that undoubtedly has helped greatly in perfecting his machines and selling methods. He took contracts for machining certain difficult pieces in large numbers, submitting prices in competition with other concerns doing contract work. The contracts obtained necessitated equipping a section of his plant on a manufacturing basis to handle this special work. His own machines were installed and fitted with appliances to facilitate the operations as far as possible, after a thorough analysis and time study had been made, and in filling the contracts, workmen were trained to handle peculiar machining propositions with facility and speed never before equalled.

The result was that the limitations as well as the capabilities of his line of tools became apparent as they never had before. Where weaknesses were discovered, the design of the machine was changed to eliminate them, but the most important result was in finding out just how the machine could be used in manufacturing work to the best advantage. This manufacturer now has a corps of salesmen who know exactly what they are talking about and can prove what they claim. They can go into a plant and size up the possibilities of machining almost any given part by their specialized practice, making estimates based on the data acquired in the home plant, and when the machines are installed, operators can be sent to instruct workmen in handling the parts to the best advantage. Consequently guarantees of production can be made and fulfilled that competing makers would not dare to offer.

* * *

THE VALUE OF A PROPER FINISH

A prospective purchaser forms his first impression of a machine largely from its appearance. Sometimes good points in the design are evident at a glance—although this is seldom the case—but whether these points of more intrinsic value show up or not, the care which has been taken in finishing the different parts of the machine contributes much to its appearance and the impression made.

In deciding upon the finish for each part, two points should be considered—the durability of a given finish under the conditions to which it will be exposed in service, and its effect on the general appearance of the machine. The argument is sometimes advanced that an outlay for unnecessary finish adds to the price which the customer must pay for his machines, without giving him any additional value. This is hardly accurate. Shop environment exerts a strong influence upon the ideals of a conscientious mechanic, and he will naturally strive for higher attainments in the quality of his work when it is produced on machines which are well finished.

From the builder's standpoint a good finish is obviously desirable, in that it constitutes an outward manifestation of the quality of the materials and workmanship put into the machine. For instance, where parts are poorly finished because the mechanical operation of the machine does not require them to be accurate, the conclusion naturally follows that the entire machine has been produced with a corresponding lack of care. In this connection, a clearly defined line must be drawn between the substitution of finish for quality in the materials used. The former cannot be regarded in any other light than a deliberate attempt at deception, but a finish that truly represents the quality of the machine, is one of the best means at the builder's command for expressing the care that has been taken in the selection of materials and in the process of manufacture.

* * *

MEASURING SCREW THREADS

Although much has been written on the characteristics of screw threads, screws and taps, and the methods by which they should be measured, it appears that there are many mechanics who are not as well informed on these subjects as they should be. Tap manufacturers constantly receive complaints that their taps are not up to size, when the whole trouble lies in the fact that the users do not know how to measure tap threads properly. Few people realize, it appears, that the outside diameter is of little practical importance, provided it is not under size. A tap is not defective if the outside diameter is considerably over size, provided the pitch or angle diameter is not above the prescribed limit. A tap should always be measured in the angle of the thread, the well-known Brown & Sharpe thread micrometer being the tool most used for this purpose. When using this micrometer, certain precautions must be taken, however, which those unfamiliar with its use are likely to overlook.

A tap manufacturer received several complaints from one of his best customers, that the taps supplied were under size. Now, as a matter of fact, while certain limits are necessary in tap manufacturing, as well as in other fields, no reputable tap maker would ever let a tap go out of his shop that was under size. Taps should always be a certain amount over size, in order to compensate for errors in lead and to provide for a reasonable amount of wear. Some tap manufacturers even instruct their inspection departments to reject taps that are exactly to size, because such a tap, having no provision for compensating for errors in the lead, is practically to be regarded as being under the standard size. Hence the manufacturer of the taps that were said to be under size, doubted the accuracy of the statement, and as the customer who had made the complaint was one well worth taking care of, he went to the latter's plant, several hundred miles distant, to personally investigate the methods and measuring tools used for testing the taps he had supplied. He found that the man who did the testing—apparently a good, all-around mechanic—measured the angle diameter of the threads with a Brown & Sharpe micrometer by holding the tap steadily in one position while he screwed down the micrometer point onto it. When measured in this way the point and anvil are likely to bear upon the surface of the thread at points below or above the actual diameter of the tap thread, so that the true dimension is not obtained, and most of the taps will appear to be below standard size. The angle diameter should be measured by passing the tap back and forth between the point and the anvil of the thread micrometer, so as to make sure that the largest dimension or the actual diameter is being measured. When the taps in question were measured in this way, they were all found to be a certain amount over the standard size, meeting all requirements.

A mistake sometimes is made in measuring threads in the angle with the B. & S. thread micrometer, by using the wrong anvil. The anvil is limited in its capacity to certain sizes of thread, and should agree with the number of threads per inch to be measured. The reason for this is that if made large enough to measure a four-threads-per-inch thread, it would be too wide at the top to measure, say, a twenty-threads-per-inch thread. If, again, it were designed to measure a twenty-threads-per-inch thread it would be so small that a four-threads-per-inch thread would not have a proper bearing in the anvil. Hence each screw thread micrometer is limited to the range of threads per inch that can be measured with the anvil furnished with the tool, and care should be used to employ these micrometers only with anvils designed for the particular numbers of threads per inch to be measured. Otherwise the readings obtained cannot be depended upon.

* * *

WIRE AND SHEET-METAL STANDARD GAGES

The confusion incident to the use of many gages is commonly experienced by all who have to specify wire and sheet metals. We have in common use the American or Brown & Sharpe gage, Birmingham or Stubs iron wire, Stubs steel wire gage, Roebling and Washburn & Moen gage, British Imperial wire gage, U. S. standard gage for sheet and plate iron and steel, Edison or circular wire gage, steel music wire gage, twist drill and steel wire gage and letter drill gage. These gages can be combined so as to give an ascending series differing approximately by thousandths or half thousandths inch, but any one of the standard gages taken by itself will be found to give a large number of sizes varying by small increments at certain stations. Between these stations there are wide gaps that the gage does not provide sizes for. If it is necessary to use sizes between those specified by a commonly used gage, other gages must be resorted to, in order to specify the desired dimensions.

The following extract from a letter received from a representative of one of the large machinery manufacturing concerns describes the situation clearly:

> I am chief draftsman at one plant of a company which operates four drafting departments. Each department specifies different gages for the same material. I find coil springs specified under four gages, and the same confusing conditions prevail with sheet metal, copper and brass. Sheet copper is specified by ounces and by the Stubs wire gage. Inasmuch as the various existing plants of our company exchange details and specifications, you can understand how confusing our drawing files are because of these conditions.

The need for a commonly accepted standard of wire and sheet-metal gages becomes more and more imperative as the manufacturing industries of the United States grow in importance and diversity. The American Society of Mechanical Engineers has appointed a committee to investigate the present systems of gages with the view of securing the adoption of some standard gage embracing the best features of all, which will be known as the standard wire and gage system recommended by the society.

The gage system, that is the system of referring to wire and sheet-metal diameters and thicknesses by numbers, is probably too firmly established to be changed. Nevertheless, it seems that we could profitably abolish the gage system in favor of a decimal system giving in every case the thickness in thousandths of an inch, instead of referring to it by an arbitrary number liable to be confused with the numbers of other gages.

* * *

The use of aluminum is constantly being extended into new fields. One of the latest applications of this metal, says the *Scientific American*, is for making foil to take the place of tin foil in wrapping up food products. Aluminum foil can now be made with a thickness of less than 0.002 inch. Aluminum powder is also coming into common use as the basis for a paint which is especially valuable for exposed metallic surfaces. Aluminum powder is very soft and adhesive, somewhat similar to graphite.

STEELS FOR TAPS, DRILLS AND MILLING CUTTERS

While any good high-carbon or high-speed steel can be used successfully for drills and milling cutters, when the requirement is simply that the steel shall possess good cutting qualities, the conditions met with in tap making make it necessary to select the steel to be used with great care. The best steel for taps must, in the first place, possess the same good qualities, as regards cutting properties and strength, as steel for other cutting tools, but, in addition, it must be so uniform in its composition that it is possible to cut the thread and harden the tap with the assurance that the lead of the thread of the hardened tool will be within certain specified limits. There are certain steels which, as far as strength and cutting qualities are concerned, would be excellent to use for taps, were it not for the fact that it is impossible to control the lead of the thread in the hardening process. Some of these steels will sometimes lengthen and sometimes become shorter in the lead, so as to make it impossible to compensate for the change in hardening by cutting the tap either long or short in the lead before hardening.

The Winter Bros. Co., of Wrentham, Mass., has experimented extensively to determine the best grade of steel to be used for high-class taps—that is, taps that after hardening will be as true to size, both as regards diameter and lead, as possible. During the last two years this firm has tried out twenty-six different kinds of steel and has finally settled upon using a steel made by an English maker, because this steel was found to be more uniform than any steel obtainable elsewhere. The results of the Winter Bros. Co.'s experiments are, in a general way, as follows:

The best steel to use for tapping cast iron and brass is one containing from two to three per cent tungsten, but otherwise having the same composition as an ordinary high-carbon steel, that is, with from about 1.15 to 1.25 per cent of carbon. This steel, if uniform in its composition, will contract or shorten 0.002 inch per inch in hardening, the same as most carbon steels. When hardening, it should be heated to a higher heat than a regular carbon steel, possibly to a temperature of 100 degrees F. higher (or up to about 1525 degrees F.) than that used for a carbon steel. It will also stand a greater variation in its hardening heat, and is, hence, easier to handle than steels that require closer watching in this respect.

The best steel for taps to be used on steel, as far as strength is concerned, is vanadium alloy steel containing from 0.25 up to 1 per cent of vanadium. The greater the vanadium content, the greater is the strength of the steel. The objection to this kind of steel for taps, however, is that it is very uncertain as regards its change in hardening. It is likely either to shorten or lengthen up to 0.002 inch per inch, and, hence, it is practically impossible to secure taps of correct lead when using this steel. The carbon content is the same as in regular carbon steels used for this purpose—from 1.15 to 1.25 per cent. An advantage of the steel is that it is easily hardened as it will stand a variation in the hardening heat of about 100 degrees F. without showing any marked difference in the qualities of the hardened tap.

It should be mentioned, however, that while the vanadium alloy steel experimented with by the Winter Bros. Co., proved very uncertain as regards its change in hardening, it is possible that the vanadium had no influence in this matter. It may be that the mere addition of vanadium to a steel which without vanadium will change uniformly, would not injure it in this respect. This, however, is a matter that has not been decided, and further experiments would prove of value.

Expensive special steels are obtainable in the market that will show practically no change whatever in either the lead or diameter of a tap when hardened, but steels of this character, while excellent in special instances, are not commercially suitable for tap making on account of the increased cost. Hence, in order to meet the requirements of the trade, the tap maker is forced to look around for a steel, the price of which is not prohibitive and which, at the same time, will meet the requirements as regards strength and uniformity.

These conditions are fairly well met in certain English and Swedish steels. These steels are more uniform as regards the change in hardening than are ordinary American tool steels, and they also differ from most of these steels in one particular: they nearly always lengthen, instead of shortening, about 0.002 inch per inch in hardening. The objections to English and Swedish steels are that the bars are not rolled as well as are those of American manufacture; they are rougher, they are not always round, and sometimes they are larger in diameter at one end of the bar than at the other.

High-speed steel is not used to any great extent for taps, one reason being the difficulty of hardening a high-speed steel tap with its fine cutting edges, which cannot be ground after hardening and which are liable to be injured by the extreme heat to which high-speed steel must be subjected in the hardening process. A high-speed steel suitable for taps should contain from 0.60 to 0.75 per cent of carbon and from 15 to 20 per cent of tungsten. This steel will harden at from 2100 to 2200 degrees F. The temper should be drawn at from 500 (in some cases) to 1000 degrees F. High-speed steel taps have been found especially advantageous for automatic screw machine work, particularly when tapping in brass or bronze. When used under these conditions, it has been found that the production per tap has been increased from five to fifteen times by the use of this material for the taps. The price of taps made from high-speed steel is, on an average, from three to four times that of ordinary carbon steel taps. The strength of high-speed steel drill rod, when properly hardened and tempered, is, on an average, slightly greater than that of carbon steel drill rod.

While, as mentioned, high-speed steel is not used to any great extent for taps at the present time, the Winter Bros. Co. states that the demand is increasing to a considerable extent. Although many tap manufacturers have had difficulty in hardening high-speed steel taps, this company has had no trouble in this respect, on account of the methods used for the purpose. A difficulty that has been met with, however, is that of keeping the cutting edges on the tools with which the high-speed tool taps and dies are threaded. The tools wear so fast that it is very difficult to cut smooth threads of correct form.

The superiority of the English and Swedish steel over the American made steel is very difficult to explain, because if a chemical analysis is made, it is often found that the American steel is freer from impurities—phosphorus and sulphur—than are these foreign steels; yet the latter will have greater strength, possess as good cutting qualities, and show greater uniformity after hardening. The cause, no doubt, is to be found in the different composition of the iron ores and the different processes to which American and foreign steels are subjected while being manufactured into tool steel.

While high-speed steel is not used to a great extent for taps, it is being used to a constantly increasing extent for milling cutters and drills. It is always advisable to use high-speed steel for these tools if they are used in regular manufacturing work. A high-speed steel cutter, for example, can be run at a cutting speed of from 100 to 125 feet per minute, while a carbon cutter should not be run at a higher speed than from 50 to 60 feet per minute. The high-speed steel cutter will also last from three to four times as long between grindings as a carbon steel cutter. Hence, it is safe to say that the output of the high-speed steel cutter between grindings will be from six to eight times that of a carbon steel cutter, while the price of high-speed steel milling cutters is only about three times that of carbon steel cutters.

Practically any good brand of carbon steel or high-speed steel is satisfactory for milling cutters or drills. Vanadium increases the strength and is, therefore, of special value in steel used for drills. High-speed steel drills have a capacity of from five to six times (in some cases up to ten times) that of carbon steel drills. For the larger sizes of drills, in manufacturing work, high-speed steel is of a decided advantage, as the price for drills larger than 5/8 inch in diameter is only about three times that of carbon steel drills. On the smaller sizes, however, the price of the high-speed steel drills increases proportionately to that of carbon steel drills, so that for a 1/8-inch drill the price is about seven times greater when using high-speed steel than when using carbon steel. Hence, the advantage in using high-speed steel for small sizes of drills is not as great, and, in some cases, the use of high-speed steel on the smaller sizes may be inadvisable.

While, as a general rule, it is advantageous to use high-speed steel cutters for all manufacturing work, there are some exceptions. Angular cutters, having a sharp corner, cannot be run at the high speed most advantageous for high-speed steels without danger of breaking off the weak points on the teeth, and, hence, in this case, the advantages of the better steel cannot be realized. There is also danger of burning the pointed cutting edges in hardening the high-speed steel cutters. Neither is high-speed steel particularly suited for gear-cutters or cutters used for work where the surface being cut is required to be especially smooth and of good finish. The high-speed steel cutter becomes dull at least as rapidly as does the carbon steel cutter, and in this state it will not produce a better surface than would a dull carbon steel cutter, but it has the advantage that it can continue to cut with its dull cutting edge on roughing work for a much longer time. Where a good finish is required, however, a sharp edge and a moderate speed are necessary, and as the advantages of the high-speed steel are not brought out under these conditions, there is no object in making cutters for this purpose from that material. The makers of milling cutters state that at the present time from 40 to 50 per cent of all milling cutters are made from high-speed steel.

Twist drills are made from high-speed steel to even a greater extent. Most firms making twist drills state that about 50 per cent, or perhaps slightly more, of their drills are made from this steel, while in the case of one firm, 75 per cent of all the drills made are high-speed steel drills. When carbon steel is used for drills, a steel containing as much as 1.30 per cent carbon is found to give the best results. A high-speed steel containing 18 per cent tungsten and 0.25 per cent vanadium is recommended for high-speed steel drills.

To illustrate the advantage of using a high-speed steel containing a high percentage of vanadium, the following example may be cited: A 3/4-inch drill made of a high-speed steel containing 1.25 per cent vanadium and 17 per cent tungsten was run at 600 revolutions per minute and with an 8-inch feed, drilling cast iron. The drill was used almost continuously and required to be ground but once a day. In a general way, it may be stated that high-speed steel drills containing this percentage of vanadium will last twice as long between grindings as ordinary high-speed steel drills. The price of drills of this material should not be more than 10 per cent greater than that of ordinary high-speed steel drills containing no vanadium.

When using high-speed steel for drills, it is necessary to allow a greater amount of stock for grinding after hardening than when using carbon steel. This is on account of the scale that is produced on high-speed steel tools in the hardening process. Ordinarily from 0.010 to 0.015 inch is allowed for grinding on ordinary carbon steel drills, while those made from high-speed steels have an allowance of about 0.025 inch.

In the making of reamers, there is no advantage in the use of high-speed steel, except in the case of chucking reamers. A high-speed steel reamer will not retain its size any longer than a carbon-steel reamer will, and with the slow speed at which hand reamers are used, there would be no other advantage to be gained.

* * *

According to an item in *Engineering*, the Russian Government has decided upon building a railway from Vladikavkas to Tiflis, right through the Caucasus mountains. The distance between these two cities by a straight line is only 125 miles, but, at present, it can be covered by rail only by making a long loop around the Caucasus chain, a journey of 990 miles long. The new project requires, however, the construction of a tunnel nearly 16 miles long, at a height more than 4000 feet above sea level. It is estimated that eight years will be required for the construction. Another interesting tunneling project of considerable magnitude is that being planned at Montreal, Canada, where it is proposed to construct a tunnel under the St. Lawrence River for the use of all Canadian railways.

DYNAMICS OF GAS ENGINE CAMS*—1

AN INVESTIGATION INTO THE RELATIVE MERITS OF DIFFERENT TYPES OF CAMS

BY M. TERRY†

To design a cam of proper shape for a given movement requires, in the majority of cases, only a general knowledge of the elements of mechanism. However, the timing cams of a gas engine—most notably a marine, automobile or aerial engine—where the parts in motion move at a high velocity, constitute an exception. To design this class of cams of the proper shape requires a full working knowledge of mechanics, and it seems that the correct design of these cams is a subject generally neglected by most draftsmen and designers. There is a great temptation to treat the timing cams as mere trips, intended to give a certain lift to their respective valves. When, therefore, a designer recognizes the importance of dynamic analysis of timing cams, he finds himself practically alone in his attempt to solve the problem, as there is no reliable data on this subject available. The discussion that has so far been published has been superficial; a volume would be required to thoroughly cover the subject and do it justice.

It is the object of the writer, in the following, to analyze the different types of cams, and to make a comparison between the designs. While the present article deals primarily with the various timing cams of automobile engines, the author believes that the study of the dynamics connected with them will be of interest to all readers of MACHINERY, whether they are directly engaged in the automobile industry or not. A short introduction on the types of engines used in self-propelled vehicles, and a survey of the present situation, will help the layman to grasp the importance of the problem and acquaint him, in a general way, with the "whys and wherefores" of the various types of valves used on the present-day motor cars.

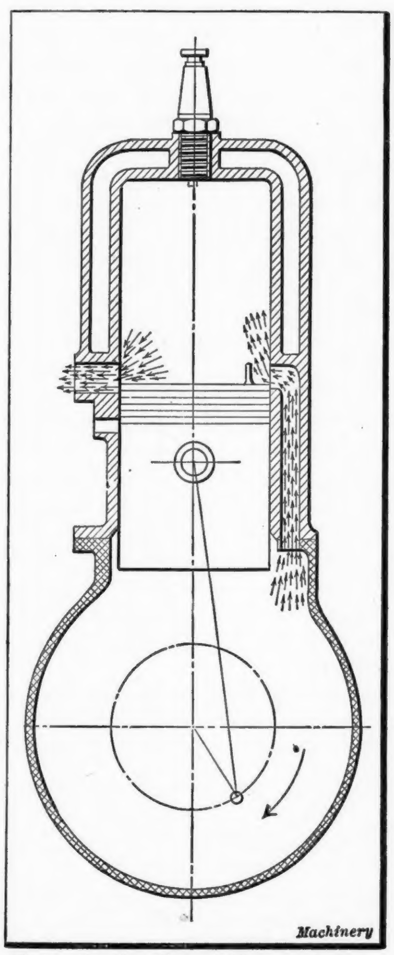

Fig. 1. Section through Three-port, Two-stroke Cycle Engine

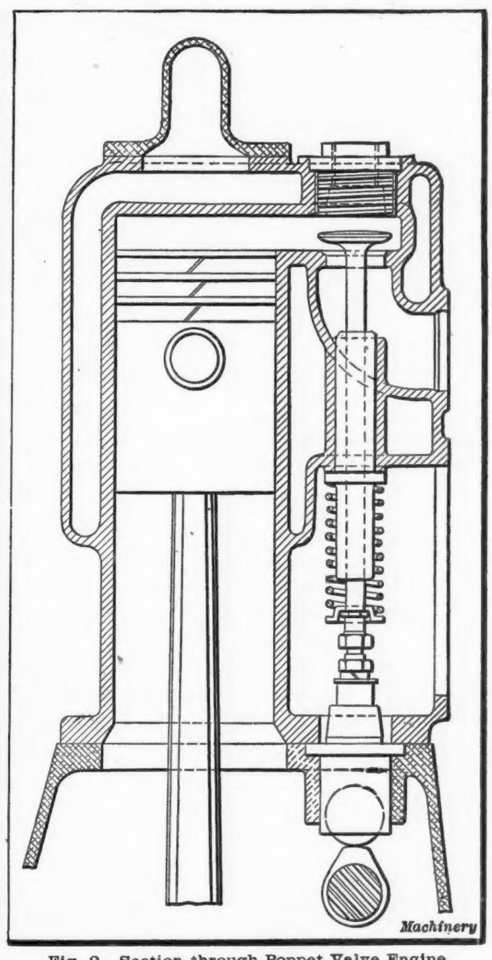

Fig. 2. Section through Poppet Valve Engine of the L-type

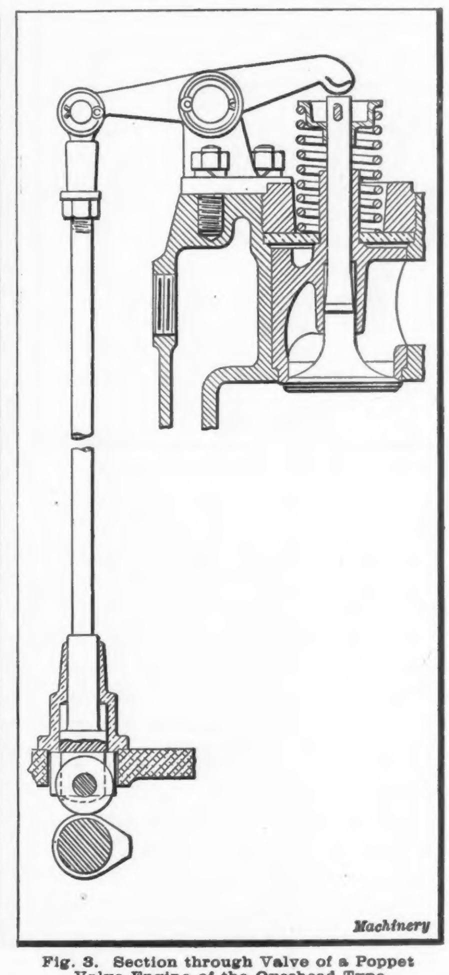

Fig. 3. Section through Valve of a Poppet Valve Engine of the Overhead Type

Need of Valves

There are two general types of gas engines, known as two- and four-stroke cycle engines; but no matter what type of engine is selected for automobile use, the cycle consists of four distinct acts, namely: suction, compression, expansion, and exhaust. In the two-stroke cycle engine these four acts are accomplished in one revolution of the crankshaft or two strokes of the piston, while in the four-stroke cycle engine these four acts are extended over a period of two revolutions of the crankshaft or four strokes of the piston.

In the two-stroke cycle engine, suitable exhaust and inlet ports are provided in the cylinder walls, which the piston in its course of travel covers and uncovers, drawing in or expelling gases, and thus acting as its own valve. (See Fig. 1.) The piston of a four-stroke cycle engine, however, cannot unassisted be its own valve, as it will uncover both ports every other stroke, while the four-cycle action requires the opening of the ports only once in four strokes of the piston. Hence the need of auxiliary valves.

Types of Valves

The great majority of automobile engines operate on the four-cycle principle. These engines can be classified in various ways—horizontal or vertical, long- or short-stroke, water- or air-cooled, etc.; but, the classification which interests us most at present is that based on the type of valves employed. When studied from this point of view, any engine can be placed in one of the three following groups:

1. Poppet valve engine, shown in Figs. 2 and 3.
2. Sliding piston-valve engine, shown in Fig. 4.
3. Rotary valve engine, shown in Fig. 5.

At present the first group is by far the largest, and the poppet valve engines represent a well tried out, established and conventional form of design. The second group, up to a

* See MACHINERY, engineering edition, February, 1911, "Timing an Offset Automobile Engine," and other articles there referred to.
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short time ago, was in its experimental stage, but with the recent advent of the "Silent-Knight" engine, it is considered by some to be the coming rival of the first group. The rotary valve engines are conceded to be in a purely experimental stage of development.

In the last group the inlet and exhaust valves have a continuous rotary motion, accomplished either by direct gearing with the crankshaft, or by means of an endless silent chain driven by the crankshaft. Thus, on account of the continuous rotary motion of the valves, the cam problem does not exist in this group.

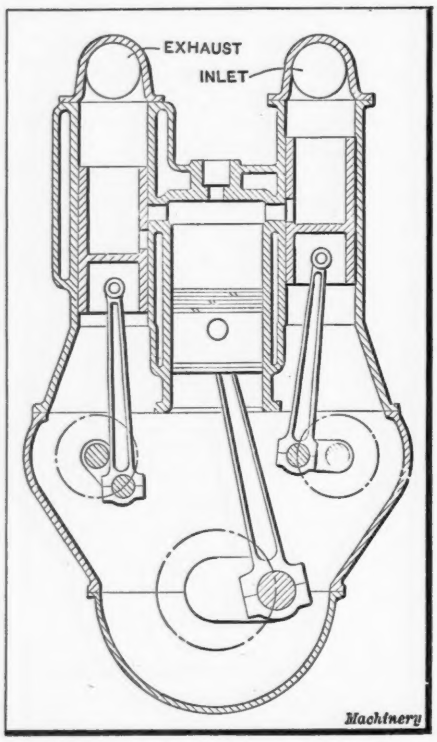


Fig. 4. Sliding Piston-valve Engine

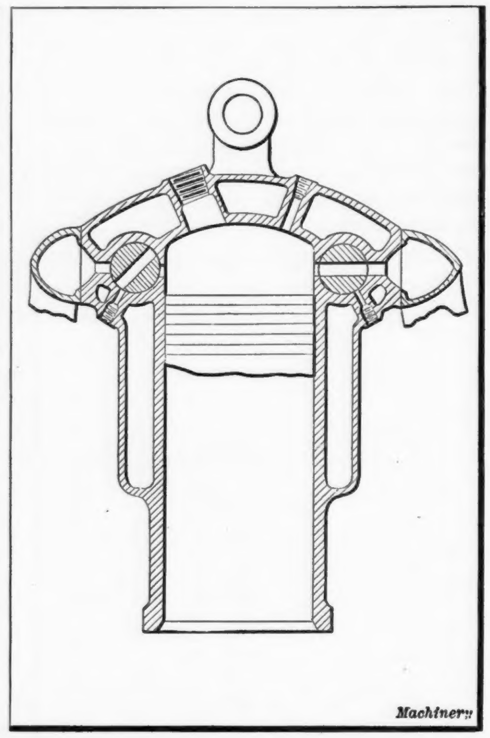


Fig. 5. Arrangement of a Rotary Valve Engine

The first two groups have the feature of reciprocating valve motion in common. The valve mechanism of the sliding sleeve engine is a miniature reproduction of the main working parts of the engine; in other words, it consists of a secondary crankshaft, connecting-rods and pistons (or sleeves as used in the "Silent-Knight" engine). The secondary crankshaft receives its motion from the main crankshaft, either by means of gears or an endless silent chain, and with the assistance of the small connecting-rods it imparts a reciprocating motion to the secondary pistons—valves or sleeve-valves, as the case may be. These valves travel in a smooth bore with no obstacles in their paths. The highest and the lowest points of their travel are determined by the throw of the secondary crankshaft. In other words, the entire linkage of the sliding piston or sleeve-valve is rigid.

As mentioned before, the poppet valves also have a reciprocating motion, but, in order to insure gas-tightness in the working cylinder, the valves must be brought tightly against their seats (flat or conical) which are formed either in the main casting or in inserted cages at right angles to the path of the valves. (See Figs. 2 and 3.) In a properly working gas engine these seats determine, then, one of the extreme points in the line of valve travel, and with this arrangement, the use of rigid linkage for poppet valve gears is out of the question. Even if it were possible by accurate machining or careful adjustment to introduce some kind of rigid linkage, the difference in contraction and expansion of the cylinder casting and the valve stems would soon result in an appreciable gap between the valves and their seats, which, in turn, would be the cause of gas leakage, poor compression, pre-ignition, back-firing and other well-known gas engine troubles; hence, the apparent necessity for a linkage with one or more "broken joints," a cam to open the valve, and a spring to close it.

It is an admitted fact that by far the greater portion of the noise caused by the modern automobile engine is due to its valves. As the noise is due directly to the pounding action of the valve gear at its broken joints and at the valve seat, no improvement along this line can be expected until designers turn their attention to the study of the various cam shapes and their respective dynamic effects.

Brief History of Development of Automobile Engine Cams

The design and construction of power plants of the early motor cars were based largely on two elements: guesswork and the then established practice in stationary and marine gas engine work. In the latter class of engines a cam of the type shown in Fig. 6 was used almost exclusively, so there is but little wonder that it was also adopted by the early automobile manufacturers. This cam is still retained in automobile engines when a so-called "mushroom" type of follower is employed; but for a roller-follower it was displaced entirely by the so-called "tangential" cam.

Some eight years ago the Buick Motor Co., then located in Detroit, Mich., and engaged in the construction of marine engines, was experimenting with its first model of self-propelled vehicles. It was not long before it was discovered that the old marine type of cam was altogether too noisy on high engine speeds. In searching for a more suitable shape of cam, it was observed that the noise seemed to decrease as the radius of the arc *AB*, Fig. 6, was increased. In the light of this discovery, the next idea that naturally suggested itself was to make the radius of the arc infinite, or, in other words, to make the arc *AB* a straight line. The results obtained were so gratifying that this new cam—now known as tangential—was immediately adopted, and the Buick Motor Co. was soon

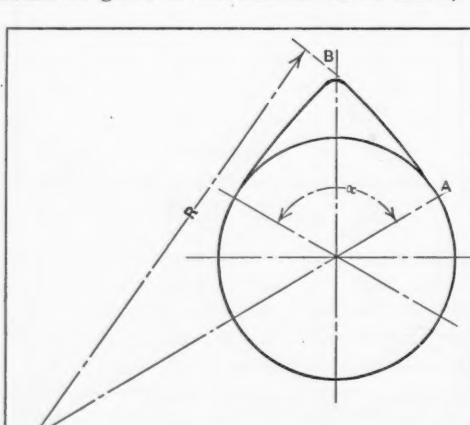


Fig. 6. Cam used on Early Automobile Engines

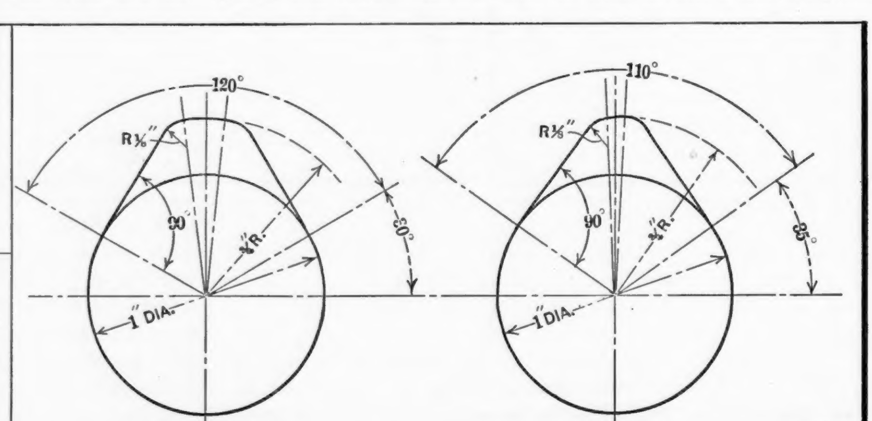


Fig. 7. Dimensions of Exhaust and Inlet Cams

followed in this by other manufacturers. At present, the vast majority of the motor car engines are equipped with tangential cams.

Whether the Buick Motor Co. deserves the entire credit for the introduction of the tangential type of cam or not, is, of course, pretty difficult to say. There is no doubt, however, that the tangential cam is merely a product of experimental development, whereas the uniformly accelerated and retarded motion cam is a product of study based on the well-known laws of falling bodies. The fact that the simple contour of the tangential cam makes it an easy manufacturing proposition and permits of ready detection of error in the inspection room, undoubtedly hastened its general adoption in the motor car field; but the very simplicity of its shape has aroused suspicion in the minds of many as to its other advantages, and has been the cause of many proposals to have it replaced by the uniformly accelerated and retarded motion cam. Perhaps one of the earliest proposals made in this country was

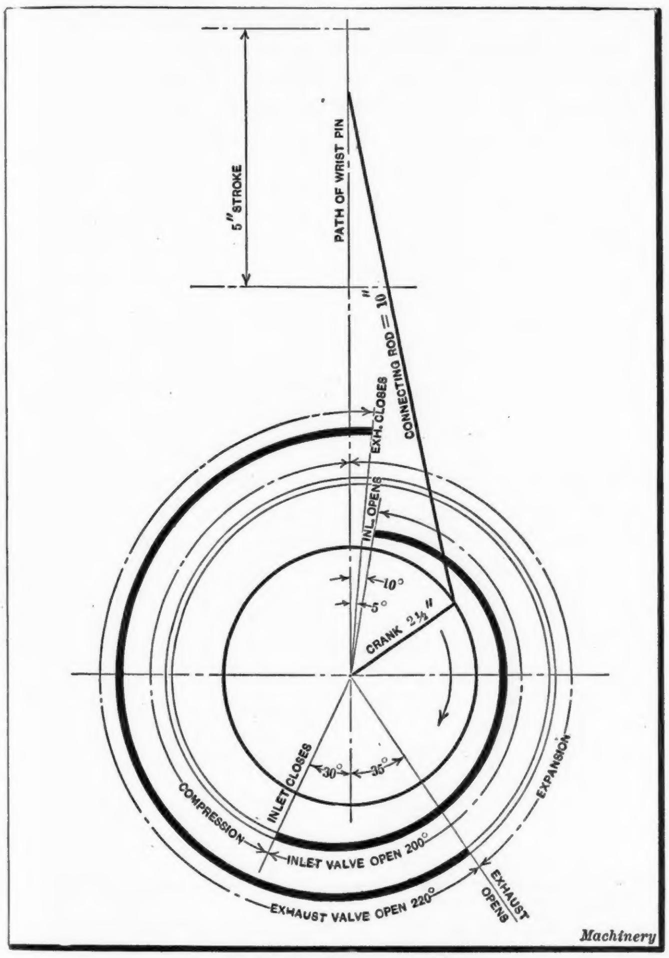


Fig. 8. Timing Diagram for Cams

published in 1905 by Mr. P. M. Heldt, editor of the *Horseless Age*. This question was again referred to in that publication in 1911 (issue of June 28, page 1083), which indicates that an opposite view—if one were ever held by anybody—was never given any publicity, or, at least, not sufficiently proved.

The author wishes to state at the outset that until a short time ago he shared Mr. Heldt's opinion, and that he was greatly puzzled by the results of a practical experiment which turned out contrary to his expectations. When he started the present investigation it was his purpose to prove the superiority of the uniformly accelerated and retarded motion cam over its tangential rival, but his logic brought him to entirely different conclusions.

Analysis of Tangential Cam

Let us now first take an actual case from practice and analyze the working conditions. Suppose an engine of 4-inch bore and 5-inch stroke is to have the following timing and general dimensions:

Exhaust opens	35 degrees ahead of the lower dead center.
Exhaust closes	5 degrees past the upper dead center.
Inlet opens	10 degrees past the upper dead center.
Inlet closes	30 degrees past the lower dead center.

Cam to be of the tangential type.

Base circle of the cam	= 1.000 inch diameter.
Cam roller circle	= 1.000 inch diameter.
Lift of cams	= 1/4 inch.
Radius of cam fillet	= 1/8 inch.
Clearance angle	= 5 degrees.

Maximum speed of the engine at which quiet operation of valves is expected, to be between 1600 and 1700 R. P. M.

In regard to timing, the reader is referred to the article, "Timing an Offset Automobile Engine," in MACHINERY, engineering edition, February, 1911. The problem of clearance and clearance angle will be taken up in detail later on.

Fig. 8, known as a timing diagram, represents the path of the piston, length of connecting-rod, length of crank, and the crank circle. The opening and closing points of the valves are referred to the latter. Thus the inlet valve of the first cylinder begins to open at the instant the first crank pin is 10 degrees past the upper dead center, etc.

It is evident then from Fig. 8 that the exhaust valves are open during 220 degrees and the inlet valves during 200 degrees of the crankshaft motion. Since the camshaft revolves at one-half the speed of the crankshaft, the angles of exhaust and inlet cams will be 110 degrees and 100 degrees, respectively. To these angles we must add 10 degrees (twice the clearance angle), giving 120 degrees for the exhaust and 110 degrees for the inlet cam. This is shown in Fig. 7. The dimensions given are those found on a manufacturing drawing. Assuming that the steel cams in their finished forms correspond exactly to the dimensions given in Fig. 7, we shall proceed to analyze their action.

From Fig. 2 it is clear that the motion of the valve gear as a whole is identical with the motion of the cam roller center. The motion of either is referred to the camshaft center, which is regarded as stationary. The camshaft turns in a left-hand direction with a constant angular speed, and the roller center (as well as the rest of the valve gear) moves up and down in a straight line with a variable speed. The relative motion of the cam and roller centers will remain unchanged if we consider the cam stationary and the roller following the contour of the cam.

Exhaust Cam

In Fig. 9 is shown the exhaust cam and its roller. The face of the cam (CC_4) is a straight line, and, as the roller moves along this line, its center A describes a straight line parallel to CC_4. As the roller center assumes its successive positions at A_1, A_2, A_3, etc., its distance from the cam center increases.

If D is the distance of A from O, in inches, corresponding to any angle θ, then:

$$D = \frac{OA}{\cos\theta} = \frac{OC + CA}{\cos\theta} = \frac{\frac{1}{2} + \frac{1}{2}}{\cos\theta} = \frac{1}{\cos\theta}$$

Now, if the roller did not rise at all, its center A would have followed the circular path AB, the center of which lies at O. Consequently, the actual rise of the roller corresponding to θ_1, θ_2, etc., is measured by A_1B_1, A_2B_2, etc.

If L stands for the lift or rise of the roller center in inches, then

$$L = D - OA = \left(\frac{1}{\cos\theta} - 1\right)$$

This equation represents the law governing the motion of the valve gear as long as the roller is in contact with the face of the cam, *i. e.*, from C to C_4. As this law is expressed in terms of θ it is of importance to us to know the limiting values of θ between which it operates.

From Fig. 9 it is clear that the limiting values are zero and the angle AOA_4. The problem is to find the value AOA_4 in degrees. For the sake of clearness, we shall use the right half of the cam; the latter being symmetrical, the same construction would apply to either side. CC_4 is tangent at C to the base circle of the cam and at C_4 to the fillet circle, the center of which lies at F. Hence CC_4 is at right angles to OA at C and to FC_4 at C_4. Draw EF parallel to CC_4. Then EF is at right angles to OA. Also, since A_4C_4 is at right angles to CC_4 at C_4, line FC_4A_4 is a straight line.

By construction,

$$EC = FC_4 = FC_7 = \frac{1}{8} \text{ inch.}$$
$$OE = OC - CE = \frac{1}{2} - \frac{1}{8} = \frac{3}{8} \text{ inch.}$$
$$OF = OC_7 - FC_7 = \frac{3}{4} - \frac{1}{8} = \frac{5}{8} \text{ inch.}$$

$$EF = \sqrt{OF^2 - OE^2} = \sqrt{\tfrac{25}{64} - \tfrac{9}{64}} = \tfrac{1}{2} \text{ inch.}$$

$$EF = CC_4 = AA_4 = \tfrac{1}{2} \text{ inch.}$$

Hence, $\tan AOA_4 = \dfrac{AA_4}{OA} = \dfrac{\frac{1}{2}}{1} = \dfrac{1}{2}$, and angle $AOA_4 = 26$ deg. 34 min.

The first law of motion of our valve gear, as we shall refer to it from now on, is expressed by the equation:

$$L = \frac{1}{\cos\theta} - 1$$

the limiting values of θ being 0 and 26 degrees 34 minutes. Now, let us look into the motion of the valve gear while the roller is traveling on the cam fillet. In order to make our discussion clearer, we shall carry out the geometrical construction simultaneously in Figs. 9 and 10. It is evident from Fig. 9 that, as the periphery of the roller moves along the fillet arc C_4C_7, the center of the roller describes the arc A_4A_7 concentric with C_4C_7. In other words, the roller center moves in an arc of a circle the center of which lies at F and the radius of which is FA_4.

Now, $FA_4 = FC_4 + C_4A_4 = \tfrac{1}{8} + \tfrac{1}{2} = \tfrac{5}{8}$ inch, and $OF = \tfrac{5}{8}$ inch. Then, if in Fig. 10, with F as a center, we describe a circle of radius FA_4, the circumference of the circle will pass through O. Note, however, that this is not always the case. In this instance it is due to the fact that the roller diameter is equal to the diameter of the base circle of the cam, and also to the fact that the radius of the fillet is made equal to one-half of the cam lift. The roller center, as explained before, describes the arc A_4A_7. Take any position of the roller center, as A_5; its distance from $O = OA_5 = OA_7 \cos\beta_5 = 1.25 \cos\beta_5$ inch.

With O as a center and OA as a radius, strike the arc AB (same as in Fig. 9). The actual lift of the roller center at A_5 equals:

$$B_5A_5 = OA_7 \cos\beta_5 - OB_5 = 1.25 \cos\beta_5 - 1.$$

Since A_5 is any position of the roller center on its path A_4A_7, the same equation will apply to every point on that path. Hence,

$$L = 1.25 \cos\beta - 1.$$

This equation represents what we shall term the second law of the valve gear motion.

It will be observed that this second law of motion is expressed in terms of a constantly decreasing angle. The lift increases as the angle β decreases. The limits of β are 0 degree and the value of angle A_4OA_7. It remains to determine the value of this angle.

Angle $AOA_4 = FA_4O = A_4OA_7$. But angle $AOA_4 = 26$ degrees 34 minutes. Hence angle $A_4OA_7 = 26$ degrees 34 minutes.

The valve, then, attains its full lift of $\tfrac{1}{4}$ inch in 53 degrees 8 minutes of the angular rotation of the cam. During the remaining portion of cam's rotation, known as dwell—equal to 6 degrees 52 minutes, considering only one-half of the cam—the valve remains stationary, and its third law of motion may be expressed as $L = \tfrac{1}{4}$ inch.

Inlet Cam

Thus far we have considered the exhaust cam only, but it can be easily demonstrated that the motion of the inlet valve gear is identical with that of the exhaust, except that it begins and ends 5 degrees later with respect to the horizontal center line of the camshaft. By comparing Fig. 11 with Figs. 9 and 10, the reader will have no trouble in discovering the truth of this statement for himself. The laws of motion and the limits between which they operate are the same for both the inlet and exhaust valves, and this fact can be taken advantage of in making the valve springs interchangeable, as well as the rest of the valve gear. It may be stated here, in a general way, that, while the roller moves along the face of the cam, the valve has an accelerated motion, and during the roller's contact with the cam fillet, the valve has a retarded motion. In fact, the sole object of the fillet is to serve as a cushion.

There are several camshafts made with the exhaust cam fillet of somewhat greater radius than that of the inlet cam, in the belief that the exhaust cam requires more cushioning. That there is absolutely no reason for it may be demonstrated by the study and comparison of Figs. 9, 10 and 11.

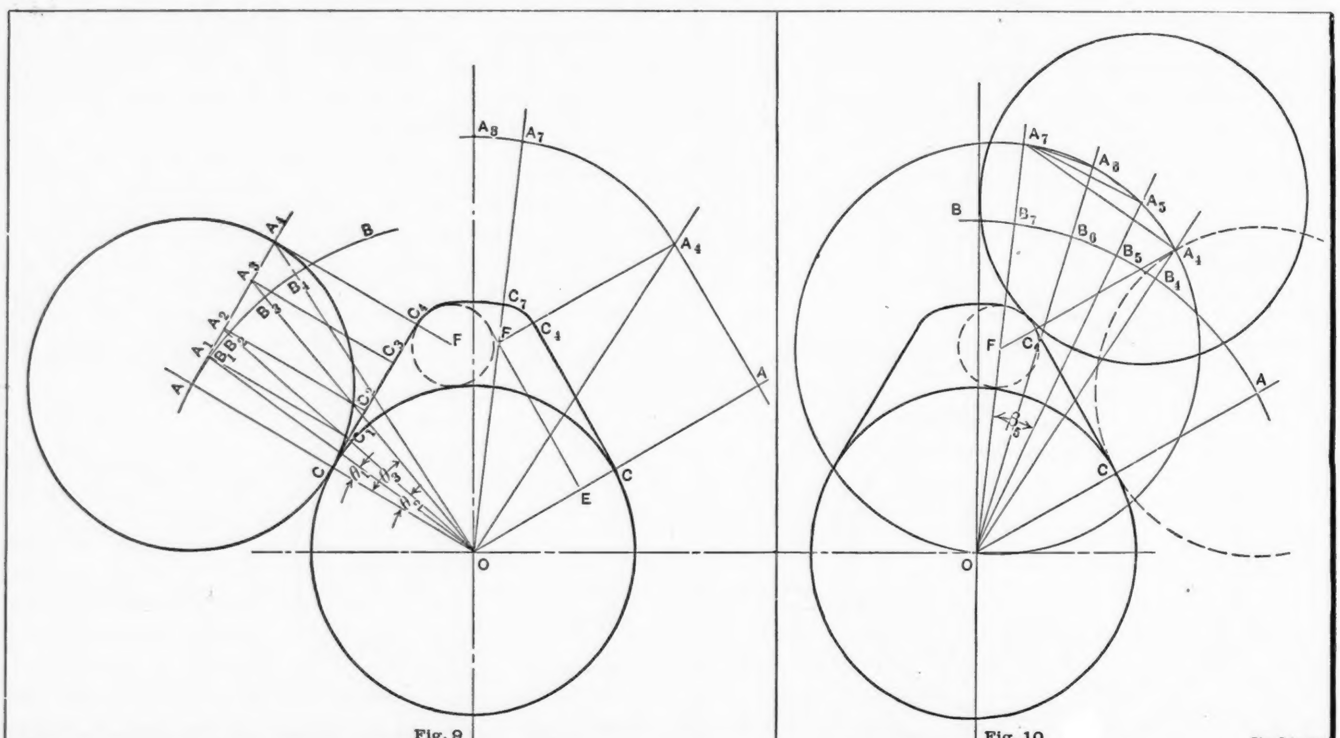
Lift, Velocity and Acceleration

Let

α = the angle formed at any instant during the upward motion of the valve by the line of cam and roller centers with the line OA. The maximum value of α is 53 degrees 8 minutes, according to Figs. 9, 10 and 11. For the sake of simplicity, we will make it 53 degrees. (Tables I and II, column 1.)

θ = the angle that enters in the equation of the first law of motion. It is identical with α except that its maximum value equals 26 degrees 30 minutes (one-half of the maximum value of α). (Table I, column 2.)

β = the angle that enters in the equation of the second law of motion. Like α and θ it represents the angular position of the cam, but is measured from the line



Figs. 9 and 10. Diagrams used for the Analysis of the Dynamics of a Tangential Exhaust Cam

OA_7. In other words, during the required motion of the valve gear, angle β decreases as α increases; the relation between β and α is expressed by the following equation: $\beta = 53$ degrees $- \alpha$ (Table II, column 2).

L = lift of valve gear in inches corresponding to any angle α. The values of L are computed from the equations representing the first two laws of motion (Tables I and II, column 4).

TABLE I. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
α	θ	$\frac{1}{\cos\theta}$	L	v	V	a	A
Deg.	Deg.						
0	0	1.0000000	0	0.0001524	0.0635		
1	1	1.0001524	0.0001524	0.0004570	0.1904	0.0003046	634.6
2	2	1.0006094	0.0006094	0.0007629	0.31785	0.0003059	637.3
3	3	1.0013723	0.0013723	0.0010695	0.4456	0.0003066	638.7
4	4	1.0024418	0.0024418	0.0013780	0.5742	0.0003085	642.7
5	5	1.0038198	0.0038198	0.0016885	0.7035	0.0003105	646.9
6	6	1.0055083	0.0055083	0.0020014	0.8339	0.0003129	651.9
7	7	1.0075097	0.0075097	0.0023177	0.9657	0.0003163	659.0
8	8	1.0098274	0.0098274	0.0026378	1.0990	0.0003201	666.9
9	9	1.0124652	0.0124652	0.0029613	1.2338	0.0003235	674.0
10	10	1.0154265	0.0154265	0.0032902	1.3708	0.0003289	685.2
11	11	1.0187167	0.0187167	0.0036238	1.5098	0.0003336	695.0
12	12	1.0223405	0.0223405	0.0039638	1.6515	0.0003400	708.3
13	13	1.0263043	0.0263043	0.0043094	1.7955	0.0003456	720.0
14	14	1.0306137	0.0306137	0.0046623	1.9425	0.0003529	735.2
15	15	1.0352760	0.0352760	0 0050235	2.0930	0.0003612	752.4
16	16	1.0402995	0.0402995	0.0053923	2.2467	0.0003688	768.3
17	17	1.0456918	0.0456918	0.0057704	2.4043	0.0003781	787.6
18	18	1.0514622	0.0514622	0.0061585	2.5657	0.0003881	808.5
19	19	1.0576207	0.0576207	0.0065570	2.7320	0 0003985	830.2
20	20	1.0641777	0.0641777	0.0069674	2.9030	0.0004104	855.0
21	21	1.0711451	0.0711451	0.0073896	3.0790	0.0004222	879.6
22	22	1.0785347	0.0785347	0.0078256	3.2607	0.0004360	908.3
23	23	1.0863603	0.0863603	0.0082760	3.4482	0.0004504	938.3
24	24	1.0946363	0.0946363	0.0087417	3.6423	0.0004657	970.2
25	25	1.1033780	0.1033780	0.0092238	3.8430	0.0004821	1004.4
26	26	1.1126018	0.1126018	0.0097243	4.0515	0.0005005	1042.6
27	27	1.1223261	0.1223261	0.0102440	4.2680	0.0005197	1082.6
28	28	1.1325701	0.1325701				

v = the velocity of the valve gear in inches per degree of the angular motion of the cam. By definition, velocity is the time-rate of change of position, and since our time unit is that corresponding to an angular movement of one degree, the numerical difference between any two successive values of L will represent the average velocity during that interval of time. (Tables I and II, column 5.)

a = acceleration in inches per degree per degree of the angular motion of the cam. By definition, acceleration is the time-rate of change of velocity, and, again, since our time unit is one degree, the numerical difference between any two successive values of v is the average acceleration during that interval of time. (Tables I and II, column 7.)

V = velocity of valves in feet per second corresponding to any value of v. (Tables I and II, column 6.)

A = acceleration in feet per second per second corresponding to any value of a. (Tables I and II, column 8.)

The last two quantities, V and A, are both expressed in gravitational units and are of great importance in our investigation. V and A can be computed from v and a respectively, but in order to do so it is necessary to establish the numerical relation between the time unit measured in seconds and the time unit as expressed in degrees.

From our specifications, the maximum speed of the engine equals from 1600 to 1700 R. P. M.; assume it to equal 1680 R. P. M. Since the camshaft revolves at one-half the speed of the engine shaft, its speed is equal to 840 R. P. M., or 14 revolutions per second. Since one revolution equals 360 degrees, the camshaft turns through $360 \times 14 = 5040$ degrees in one second. Therefore, the time unit corresponding to one degree is 1/5040 second. For the sake of simplicity we shall assume one degree = 1/5000 second, or one second = 5000 degrees. Hence,

$$V = \frac{5000\,v}{12} \quad \text{(Tables I and II, column 6.)}$$

$$A = \frac{5000 \times 5000 \times a}{12} = \frac{25{,}000{,}000\,a}{12}$$

(Tables I and II, column 8.)

It may occur to some that in carrying out the values of L, column 4, Tables I and II, to seven decimal places one loses "the sense of values," and that in practice both the cam and the roller will vary enough to affect the third decimal place by one or two units. Indeed, were we to attach importance to any one value of L, it would be folly to carry it out beyond the third decimal place, but what we aim to determine is not the individual values of L, but the succession of these values. This method gives us four significant places for the values of a (column 7) which is not too much. If the cam and its follower were a few thousandths of an inch below or above their standard dimensions, the relative differences would be the same throughout columns 3 and 4 of both tables. The values of a would all be changed, but these new values would differ from one another in the same manner as those given in Tables I and II.

It must be borne in mind that the method pursued for finding v and a is an approximate one. The exact values of v and a at any instant can be obtained only by differential calculus. However, since the values of L were taken close together (one degree apart) this method gives as accurate results as are required for our purpose.

Tables I and II cover only the upward motion of the valve, but a little thought will show that the same values of v and a and of V and A taken in reverse order will apply to the downward motion as well, with a changed sign of acceleration. The tables for the inlet cam will be precisely the same. The tables as well as the acceleration curve plotted from them (see Fig. 12) show that

TABLE II. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
α	β	1.25 cos β	L	v	V	a	A
Deg.	Deg.						
25	28	1.1036845	0.1036845	0.0100737	4.1970		
26	27	1.1137582	0.1137582	0.0097343	4.0557	−0.0003394	−707.1
27	26	1.1234925	0.1234925	0.0093922	3.9134	−0.0003421	−712.7
28	25	1.1328847	0.1328847	0.0090471	3.7694	−0.0003451	−719.0
29	24	1.1419318	0.1419318	0.0086992	3.6245	−0.0003479	−724.8
30	23	1.1506310	0.1506310	0.0083490	3.4788	−0.0003502	−729.6
31	22	1.1589800	0.1589800	0.0079953	3.3312	−0.0003537	−736.9
32	21	1.1669753	0.1669753	0.0076404	3.1833	−0.0003549	−739.3
33	20	1.1746157	0.1746157	0.0072827	3.0344	−0.0003577	−745.2
34	19	1.1818984	0.1818984	0.0069221	2.8842	−0.0003606	−751.2
35	18	1.1888205	0.1888205	0.0065603	2.7334	−0.0003618	−753.7
36	17	1.1953808	0.1953808	0.0061962	2.5815	−0.0003641	−758.5
37	16	1.2015770	0.2015770	0.0058302	2.4292	−0.0003660	−762.5
38	15	1.2074072	0.2074072	0.0054624	2.2758	−0.0003672	−765.0
39	14	1.2128696	0.2128696	0.0050929	2.1220	−0.0003695	−769.8
40	13	1.2179625	0.2179625	0.0047220	1.9674	−0.0003709	−772.7
41	12	1.2226845	0.2226845	0.0043494	1.8122	−0.0003726	−776.2
42	11	1.2270339	0.2270339	0.0039758	1.6565	−0.0003736	−778.3
43	10	1.2310097	0.2310097	0.0036005	1.5001	−0.0003753	−781.8
44	9	1.2346102	0.2346102	0.0032249	1.3436	−0.0003756	−782.4
45	8	1.2378351	0.2378351	0.0028475	1.1864	−0.0003774	−786.2
46	7	1.2406826	0.2406826	0.0024696	1.0289	−0.0003779	−787.2
47	6	1.2431522	0.2431522	0.0020911	0.8712	−0.0003785	−788.5
48	5	1.2452433	0.2452433	0.0017117	0.7132	−0.0003794	−790.4
49	4	1.2469550	0.2469550	0.0013318	0.5549	−0.0003799	−791.4
50	3	1.2482868	0.2482868	0.0009518	0.39657	−0.0003800	−791.6
51	2	1.2492386	0.2492386	0.0005709	0.23786	−0.0003809	−793.5
52	1	1.2498095	0.2498095	0.0001905	0.07937	−0.0003804	−792.0
53	0	1.2500000	0.2500000				

the cam starts the valve gear on its upward journey with an ever-increasing acceleration. Readers familiar with mechanics know that even were the acceleration constant, the cam and its follower would be in contact under pressure, for a constant acceleration of the follower can be due only to a constant force acting on it, *i. e.*, a constant pressure of the cam on the follower. Since, in our case, the acceleration is of a gradually increasing nature, it is more than sufficient to keep the cam in contact with its follower, and consequently the pressure of the spring is unnecessary as long as the roller moves along the face of the cam. At $a = 26$ degrees 30 minutes (point B in acceleration diagram, Fig. 12), the state of things changes. Acceleration vanishes instantly, but by this time the valve gear has acquired a definite velocity. Owing to this velocity it possesses a certain amount of energy which is consumed in compressing the valve spring through a certain distance. The spring absorbs this energy at the expense of the now decreasing velocity of the valve. A decreasing velocity can be due only to a negative acceleration; in other words, the spring does all the work of retardation (neglecting slight friction and force of gravity). It can do it in a number of different ways, but the best way is plainly the one that will insure contact (under slight pressure) of the cam with its follower, and, in order to do that, the spring must exert pressure sufficient to produce accelerations somewhat greater than those shown in Column 8, Table II, and represented in Fig. 12 by the portion BC of the curve.

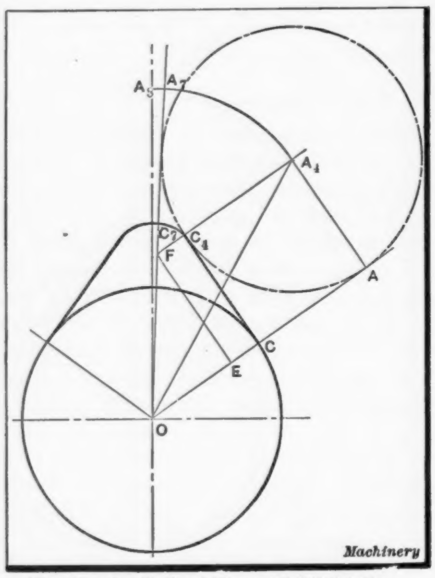


Fig. 11. Analysis of Tangential Inlet Cam

The first part of the downward motion of the valve is due entirely to the pressure of the spring. The motion is symmetrical with that of the last part of the upward motion and a spring designed for this will be satisfactory for both motions. At D, Fig. 12, the acceleration changes sign and becomes negative—this time the cam doing all the work of retardation. If the spring pressure is to vanish instantly at this point, the cam will retard the valve just as effectively.

TABLE III. DATA FOR DRAWING SPRING PRESSURE CURVE

L	A	T	L	A	T
0.114	707	35.35	0.227	778	38.9
0.142	725	36.25	0.238	786	39.3
0.175	745	37.25	0.245	790	39.5
0.202	763	38.2	0.250	792	39.6
0.218	773	38.7	.....	...	....

Valve Springs

There remains now only the problem of designing a suitable valve spring. Let,

T = pressure of the spring in pounds at any point between B and C, Fig. 12.

A = acceleration (in feet per second per second) necessary at that point to keep the cam in contact with its follower.

m = mass of the reciprocating parts of the valve gear, including one-half the mass of the spring itself.

Then, $T = m \times A$.

Assuming the weight w of the reciprocating parts to be 1.6 pound,

$$m = \frac{w}{g} = \frac{1.6}{32} = \frac{1}{20}$$

$$T = A \times \frac{1}{20} = \frac{A}{20}$$

The valve springs most commonly used on automobile engines are of the type shown in Figs. 2 and 3. Any helical spring develops pressure in direct proportion to the amount of distortion it undergoes, provided its elastic limit is not exceeded. It will, therefore, prove useful to plot a curve BC, Fig. 14, using lifts for abscissas and spring pressures for ordinates. This can be easily accomplished by selecting, from Table II, eight or ten values of L and the corresponding values of A. Table III is made up of these values selected at random; the third column of this table gives the spring pressures in pounds. In Fig. 14, the curve BC corresponds to curve BC in Fig. 12.

The compression curves of the springs shown in Figs. 2 and 3 are straight inclined lines (within the elastic limit), and in accordance with our preceding discussion the compression curve of our spring must be slightly above BC, if the cam and its follower are to be kept in contact under pressure. There are two more conditions to which our spring must conform. The first of these is that the maximum safe load of the spring should not be exceeded when the valve reaches its full lift. The second condition is that, when the piston is drawing in a fresh charge, the spring pressure must be sufficient to keep the exhaust valve tight on its seat against the back pressure of the exhaust gases in the muffler.

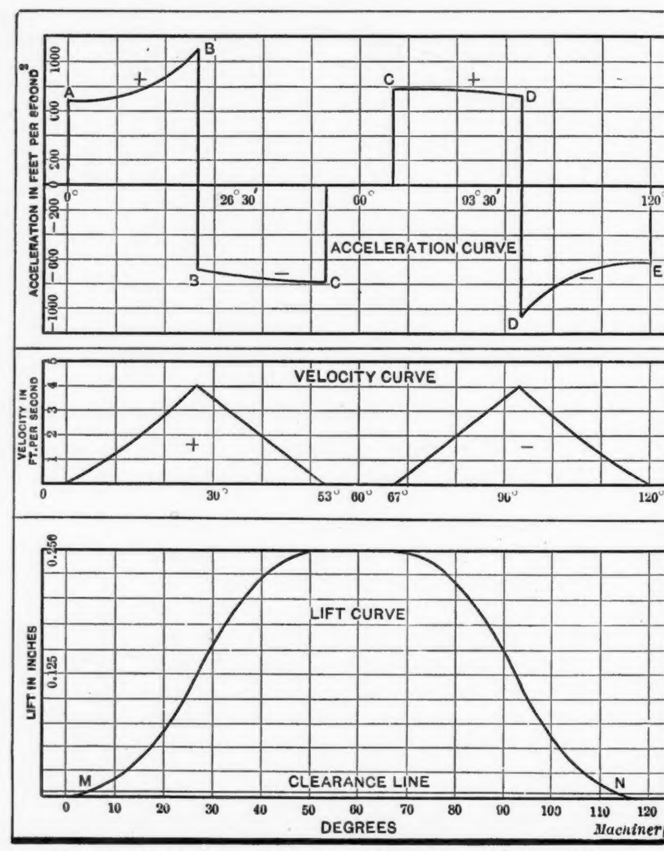


Fig. 12. Acceleration, Velocity and Lift Curves of Tangential Cam

Suppose that the valve is of the dimensions shown in Fig. 13, that the back-pressure of exhaust gases is about 8 pounds gage, or about 23 pounds absolute, and that the pressure in the cylinder on the suction stroke drops to 12 pounds absolute. Total difference in pressures on valve head is:

$$23 \times \frac{\pi}{4} \times \left[(1\tfrac{1}{2})^2 - \left(\frac{5}{16}\right)^2\right] - 12 \times \frac{\pi}{4} \times \left(1\frac{11}{16}\right)^2 = 12$$

pounds.

When the valve is closed, *i. e.*, when $L = 0$, the spring pressure must be somewhat in excess of 12 pounds or else gas-tightness at the seat will not be secured. In practice, probably nothing short of 30 pounds would do. There are two reasons for this discrepancy between theory and prac-

tice: 1. The pressure in the exhaust header, which is located in the immediate neighborhood of the exhaust valves, must, on account of restricted passages, be somewhat higher than the back-pressure in the muffler; 2. The exhaust of burnt gases does not take place in a continuous stream, but comes in "puffs," and, thus, the pressure in the header is of a pulsating nature, with a maximum instantaneous value considerably in excess of the muffler pressure.

In designing a spiral spring, the two following formulas

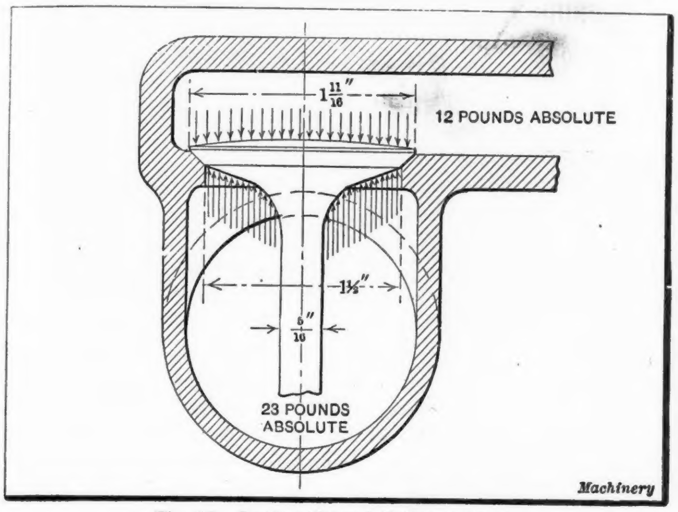


Fig. 13. Section through Exhaust Valve

given by Unwin (Part I, page 39) are generally used by designers:

$$P_1 = \frac{180{,}000\, d^4}{nr^3} \qquad (1)$$

$$P = \frac{12{,}000\, d^3}{r} \qquad (2)$$

where P = maximum safe load of the spring in pounds.
P_1 = pressure on spring in pounds per inch of deflection,
n = number of full coils,
d = diameter of wire in inches,
r = mean radius of the spring.

Cut and try methods are generally applied to Formulas (1) and (2). Practical considerations, however, greatly reduce the tedious work of calculating the springs. The amount of room available for springs limits their outside diameter; in

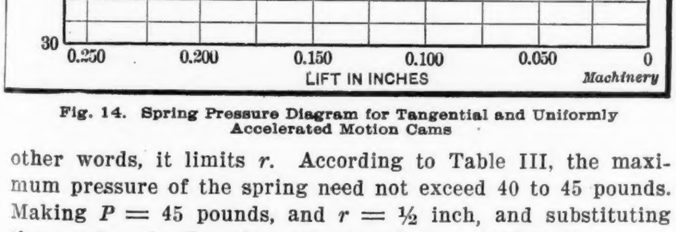


Fig. 14. Spring Pressure Diagram for Tangential and Uniformly Accelerated Motion Cams

other words, it limits r. According to Table III, the maximum pressure of the spring need not exceed 40 to 45 pounds. Making P = 45 pounds, and $r = \frac{1}{2}$ inch, and substituting these values in Equation (2) we get d = 0.123 inch.

The nearest size of wire is No. 11 B. W. G., which is equal to 0.120 inch. Therefore, making d = 0.120, retaining 45 for the value of P, and solving for r in Equation (2), we get r = 0.462 inch.

In Equation (1) d and r are now practically determined. Referring to Table III it will be seen that the spring pressure must increase by about 4 pounds with a corresponding compression of about $\frac{1}{8}$ inch; in other words the spring pressure per inch of deflection $= \frac{4}{\frac{1}{8}} = 32$ pounds.

Making P_1 = 35 pounds in Equation (1) and solving for n, we get n = 10.8 coils.

If we make the spring with eleven free coils:

$$P_1 = \frac{180{,}000 \times 0.00020736}{11 \times 0.0986} = 34.4 \text{ pounds.}$$

Now, if the spring be made 1 inch longer in its free state than when it is in place with the valve closed, its initial pressure will amount to 34.4 pounds, and with the valve at its full lift, the final pressure of the spring will amount to 34.4 × 1.25 = 43 pounds. The pressure line of the spring is represented graphically by line *DE* in Fig. 14. It will be observed that the spring thus designed fulfills all requirements. The ideal spring pressure line is the one that will practically coincide with line *BC*.

So far as design is concerned, our problem is now completely solved. However, if we wish to look further into the advantages and disadvantages of the tangential cam, we must compare it with some other type of cam. This method of comparison is a very useful one, for it eliminates the necessity of several assumptions, and at the same time brings out definitely both the desirable and the undesirable features of cams. A comparison with the uniformly accelerated and retarded motion cam will be made in the next installment of this article.

* * *

EDUCATION IN ACCIDENT PREVENTION

At the accident prevention meeting of the Conservation Congress at Indianapolis, October 2, Mr. Melville W. Mix, president of the Dodge Mfg. Co., Mishawaka, Ind., read a paper in which the general principles of accident prevention in his plant were outlined, and from which we have made the following extract:

"With the development of the new doctrine of indemnity in the case of occupational accidents, which disregards the assumption of risk, negligence of fellow employes or contributory negligence, as defenses to the employer, it becomes necessary to consider the question from a purely educational standpoint, establishing collaterally therewith the doctrine of prevention of accidents.

"In order to bring the matter of safety directly to the employes of the Dodge Mfg. Co., the management has prepared a plan of education and competition between departments and their foremen. This is in the form of a percentage score board, such as indicates the standing of teams in the base ball leagues. The starting point is 1000. Each division is penalized according to its accidents, minor accidents of less than one day's absence not, as yet, being considered. Each day's absence bears a percentage charge in proportion to the total number of men-days per month in each division.

"The foremen of all the divisions scoring 1000, or those holding the first three places below 1000 will receive prizes for personal interest each month. The foreman scoring the largest number of first monthly prizes for one year will receive a special prize at the end of the year. All divisions holding a percentage for the year of 1000, or the highest annual percentage, will receive two days' extra pay."

The plan is in a rather crude form at present, but it will be of daily interest because of its competitive nature, and will facilitate the inculcation of preventive measures and of individual care and forethought, as well as speedy and prompt attention to reduce the severity of the accident and shorten the time of absence. The interest in the daily score board, which is 24 feet long and erected at the main works entrance, will influence all the workers.

* * *

The council of the International Association of Chemical Societies, which met in Berlin last April, unanimously approved of Prof. Ostwald's suggestion in favor of a series of uniform sizes for chemical publications. It was recommended that all the affiliated societies adopt, for their publications, the uniform size of 16 by 22.6 centimeters (about 6 5/16 by 8 7/8 inches.). It certainly would be desirable if book publishers in general could agree on certain standard sizes for all scientific and mechanical books.

MILLING SAD IRONS

This seems to be the age of the milling machine, as it is used on work hitherto thought to be entirely out of its range. Automobile manufacturers early appreciated the possibilities of this type of machine and have achieved wonderful results from its use. It is interesting to note, however, that other manufacturers have also awakened to the possibilities of milling on certain classes of work, and have in some cases increased the output greatly. An excellent example of the application of the Becker vertical type of milling machine to the manufacture of sad iron bases was obtained in the shop of the Dover Mfg. Co., Canal Dover, Ohio.

The former method of machining these sad iron bases—removing 1/8 inch of material from the base—was to hold one base at a time in a chuck, and remove the material with a single cutting tool. A row of the machines formerly used for this purpose is shown in Fig. 1, where it will be seen that they resemble somewhat in appearance an old type lathe. Fig. 3 shows a closer view of the tool-slide and chuck in which a sad iron base is retained.

Fig. 1. "Old Lathes" formerly used for machining Sad Iron Bases

The drive is from a countershaft to the pulley *A*, which is held on the back-gear shaft carrying the pinion *B*, this gear meshing with the large gear *C* on the work spindle *D*, Fig. 1. Located on the rear end of the work spindle is another pinion *E*, which through the medium of an intermediate gear *F*, drives the back shaft *G*. Shaft *G*, through bevel gears, rotates the screw *H*, which imparts the traverse movement to the slide *I*. A pinion *J*, held on the front end of the screw, provides a means for rotating the latter by hand through the gear *K* and the handle shown.

The chuck used for holding the work is a rather antique looking affair, consisting of a plate screwed to the spindle, and recessed to receive the two jaws *L* and *M*, which are milled out to suit the shape of the casting. The work is clamped by the set-screws *N* and *O*, the screw *O* extending through the jaw *L*, while the screw *N* bears on a spring plunger that pinches the casting. It is only necessary to operate the set-screw *N* to clamp the work, when the set-screw *O* has once been properly set. (Note the fancy guard for the set-screw.)

These machines were arranged in a row so that one man could attend to the "gang", removing and inserting the work, keeping the cutting tools sharp, etc. Great difficulty was experienced in producing a smooth surface at the extreme ends of the sad iron base, owing to the cutting tool *P* springing when leaving and approaching the work. This necessitated rotating the work slowly by means of the back-gear arrangement, and using a fine feed. With five of these machines (only four are shown in Fig. 1) it was possible by keeping them going continually to turn out 1000 sad irons per day—at a rate of one casting from each machine every three minutes.

Upon the installation of the two Becker vertical milling machines shown in Fig. 2, which were equipped with rotary fixtures, this production was increased by 300 per cent (to 4000 sad iron bases per day), with a corresponding increase in the quality of the work. Instead of one man attending to five machines, each machine is attended by an operator whose attention is confined to removing and inserting the work. The milling is accomplished with a high-speed steel inserted tooth milling cutter, having fourteen blades, which support each other, obviating chatter and enabling the use of a coarse feed.

A closer view of the rotary milling fixture used is shown in Fig. 5, while Fig. 4 shows the construction of the clamping arrangement. The fixture consists of a circular base *A*, which is clamped, as shown, to the rotary table and is provided with cast projections forming the base of a three-point support for the sad iron base. As shown in Fig. 4, the sad iron base rests on a hardened block *B*, and is supported and clamped on the forward end by two hardened studs *C* which are beveled to grip the casting securely, when it is forced against them by the strap *D*. This strap is provided with a heel, and is located in a machined recess in the lug *E* to which the hardened block *B* is also fastened. The clamping strap is held against the work by a winged nut *F*, screwed onto a stud that is located in the cast lug.

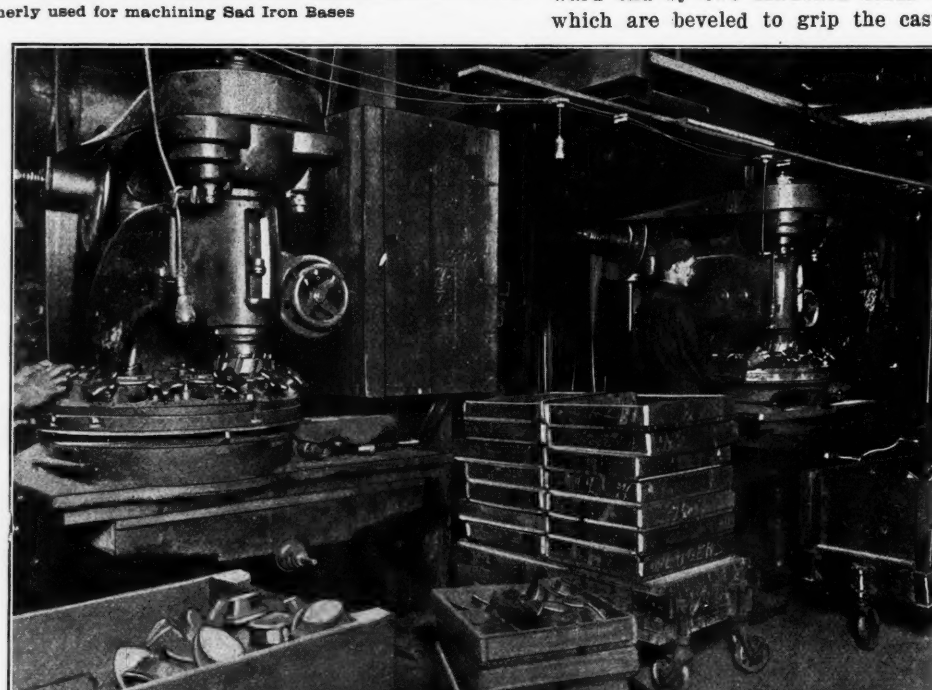


Fig. 2. The Improved Method of machining Sad Iron Bases

In operation, as the table rotates, the operator releases the clamping nut, removes the casting, brushes off the "seats," and inserts a rough casting, repeating this order as the castings are machined. It requires approximately 2½ minutes for the fix-

ture to make one revolution, and in this time 14 sad iron bases are machined, as against one sad iron base in 3 minutes by the old method. As before, ⅛ inch of material is removed from the base of the castings.

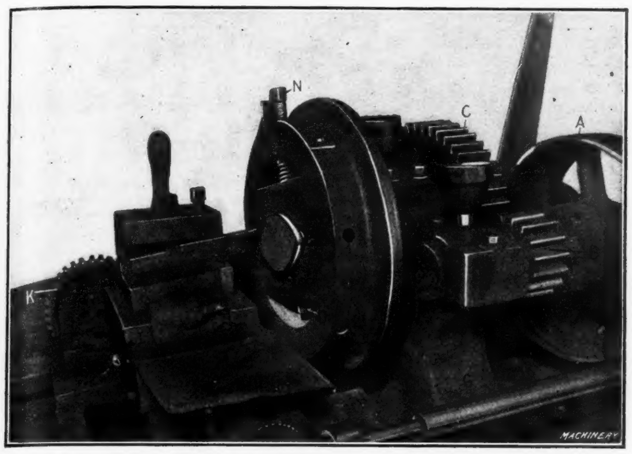


Fig. 3. View showing Construction of Old Chuck and Tool-slide

The machining of these sad iron bases is an excellent example of the application of rotary continuous milling fixtures to the manufacturing of castings in large quantities, and illustrates in a forceful manner the advance made in manufacturing methods. The fixtures used were designed and built by the Becker Milling Machine Co., Hyde Park, Mass.

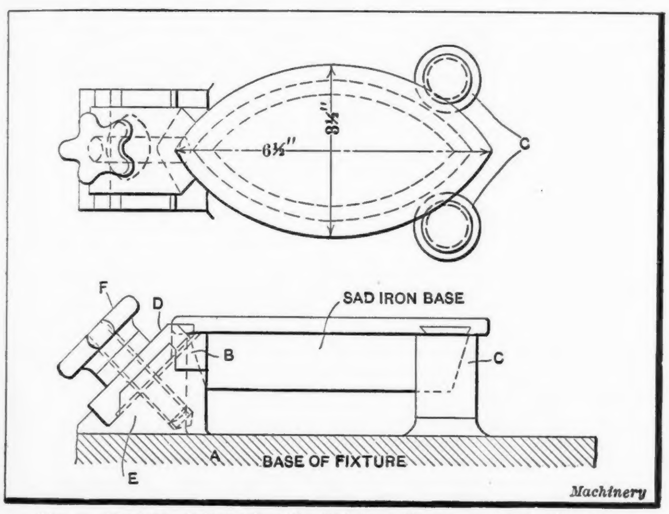


Fig. 4. Method of Clamping the Sad Iron Bases on the Continuous Rotary Milling Fixture

* * * D. T. H.

The Minneapolis, St. Paul & Sault Ste. Marie Railway has posted a notice in its car shops to the effect that employes will not be permitted to wear neckties or torn overalls while at work. This order has been issued with a view to reducing the danger of accidents in the shops, as many injuries have been due to the men having been drawn into machinery by their neckties or by ragged garments being entangled in the mechanism.

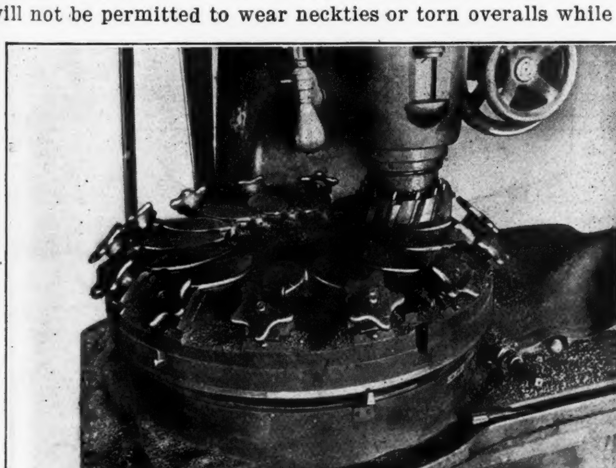


Fig. 5. Continuous Rotary Milling Fixture used on the Becker Vertical Milling Machines for holding the Sad Iron Bases while machining

FLUTING ANGULAR MILLING CUTTERS AND TAPERED REAMERS*†

BY GEORGE W. BURLEY‡

The "lands" which are formed on the teeth of all kinds of milling cutters and reamers, except those which are of the formed variety and those which are eccentrically relieved, whether cylindrical or conical, usually have a uniform width from one end of the cutter or reamer to the other. It is, of course, quite possible to arrange the cutter or reamer blank in the milling machine dividing head for the fluting or grooving operation so that the lands which are formed on the teeth will be tapered. The latter form of land is, however, never used in connection with axial and radial teeth, in good practice, and is very rarely used in connection with inclined teeth—that is, teeth on angular milling cutters and tapered reamers.

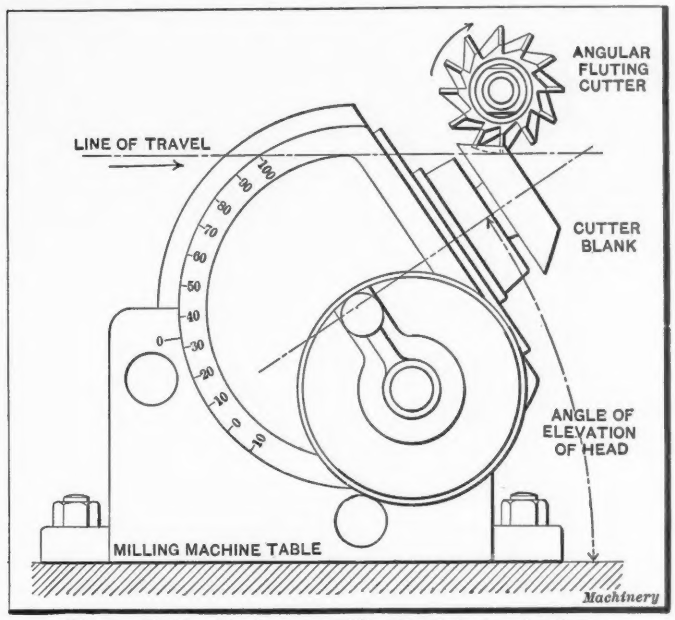


Fig. 1. Dividing Head set for Milling Teeth in Angular Cutter

For the formation of lands of uniform width on radial teeth on the sides and ends of cylindrical milling cutters and on inclined teeth on the conical surfaces of angular milling cutters and tapered reamers, it is necessary to set the axis of the cutter or reamer and, therefore, the axis of the dividing head, at a definite angle with respect to the horizontal axis of the dividing head and footstock centers. This angle depends upon several factors, which, in the case of angular milling cutters and tapered reamers, are enumerated and dealt with below. This angle is known as the "angle of elevation" of the dividing head (see Fig. 1). For cutters having radial teeth, the question of its determination and that of the depth of cut required was discussed in the November and December, 1911, numbers of MACHINERY by the present writer. The problem involving the determination of the values of this angle and the required depth of cut for angular cutters and tapered reamers is, however, more complicated, and is considered in the present article.

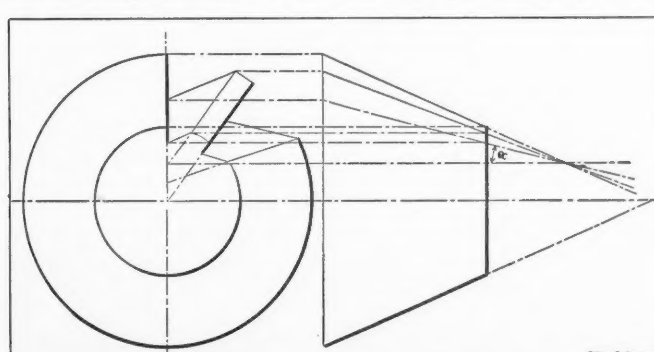


Fig. 2. Diagrammatical Representation of Principles involved in Milling Teeth in Angular Cutters

* With Data Sheet Supplement.
† See also MACHINERY, March, 1912, "Milling Axial Teeth in Cutter and Reamer Blanks," and the articles there referred to.
‡ Address: University of Sheffield, Sheffield, England.

TABLES V AND VI. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 16

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	46° 20′		0.4025		0.3813		0.3389		0.2965
	50	49° 39′		0.3500		0.3314		0.2942		0.2570
20	60	55° 40′	0.020	0.2491	0.040	0.2359	0.080	0.2095	0.120	0.1831
	70	60° 26′		0.1670		0.1581		0.1403		0.1225
	80	64° 36′		0.0946		0.0895		0.0794		0.0693
	45	37° 40′		0.4145		0.3925		0.3185		0.3045
	50	40° 51′		0.3575		0.3385		0.3005		0.2625
30	60	46° 20′	0.020	0.2574	0.040	0.2438	0.080	0.2166	0.120	0.1894
	70	50° 40′		0.1767		0.1673		0.1485		0.1297
	80	54° 28′		0.1052		0.0996		0.0884		0.0772
	45	30° 10′		0.4176		0.3954		0.3510		0.3066
	50	32° 50′		0.3640		0.3446		0.3058		0.2670
40	60	37° 33′	0.020	0.2662	0.040	0.2520	0.080	0.2236	0.120	0.1952
	70	41° 20′		0.1860		0.1760		0.1560		0.1360
	80	44° 40′		0.1144		0.1084		0.0964		0.0844
	45	26° 24′		0.4270		0.4042		0.3586		0.3130
	50	28° 58′		0.3698		0.3500		0.3104		0.2708
45	60	33° 25′	0.020	0.2686	0.040	0.2542	0.080	0.2254	0.120	0.1966
	70	36° 51′		0.1897		0.1787		0.1567		0.1347
	80	39° 55′		0.1185		0.1121		0.0993		0.0865
	45	23° 35′		0.4200		0.3970		0.3510		0.3050
	50	25° 30′		0.3678		0.3482		0.3090		0.2698
50	60	29° 21′	0.020	0.2621	0.040	0.2495	0.080	0.2243	0.120	0.1991
	70	32° 30′		0.1925		0.1821		0.1613		0.1405
	80	35° 14′		0.1220		0.1155		0.1025		0.0895
	45	17° 25′		0.4114		0.3896		0.3460		0.3024
	50	18° 40′		0.3705		0.3510		0.3120		0.2730
60	60	21° 38′	0.020	0.2750	0.040	0.2603	0.080	0.2309	0.120	0.2015
	70	24° 0′		0.1979		0.1871		0.1655		0.1439
	80	26° 7′		0.1278		0.1210		0.1074		0.0928
	45	11° 0′		0.4330		0.4098		0.3634		0.3170
	50	12° 14′		0.3727		0.3527		0.3127		0.2727
70	60	14° 14′	0.020	0.2770	0.040	0.2622	0.080	0.2326	0.120	0.2030
	70	15° 50′		0.2008		0.1900		0.1684		0.1468
	80	17° 15′		0.1328		0.1267		0.1115		0.0973
	45	5° 30′		0.4269		0.4040		0.3582		0.3124
	50	6° 3′		0.3745		0.3545		0.3145		0.2745
80	60	7° 3′	0.020	0.2799	0.040	0.2649	0.080	0.2349	0.120	0.2049
	70	7° 51′		0.2038		0.1929		0.1711		0.1493
	80	8° 35′		0.1343		0.1271		0.1127		0.0983

Number of Teeth in Cutter to be Fluted = 18

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	49° 26′		0.3513		0.3297		0.2865		0.2433
	50	52° 18′		0.3040		0.2852		0.2476		0.2100
20	60	57° 31′	0.020	0.2162	0.040	0.2029	0.080	0.1763	0.120	0.1497
	70	61° 45′		0.1435		0.1347		0.1171		0.0995
	80	65° 24′		0.0802		0.0752		0.0652		0.0552
	45	40° 31′		0.3570		0.3350		0.2910		0.2470
	50	43° 20′		0.3109		0.2919		0.2539		0.2159
30	60	48° 7′	0.020	0.2238	0.040	0.2100	0.080	0.1824	0.120	0.1548
	70	51° 58′		0.1516		0.1422		0.1234		0.1046
	80	55° 19′		0.0885		0.0831		0.0723		0.0615
	45	33° 2′		0.3615		0.3395		0.2955		0.2515
	50	35° 5′		0.3153		0.2959		0.2571		0.2183
40	60	39° 14′	0.020	0.2290	0.040	0.2149	0.080	0.1867	0.120	0.1585
	70	42° 33′		0.1591		0.1493		0.1297		0.1101
	80	45° 30′		0.0963		0.0904		0.0786		0.0668
	45	28° 48′		0.3650		0.3430		0.2990		0.2550
	50	31° 0′		0.3211		0.3011		0.2611		0.2211
45	60	34° 57′	0.020	0.2340	0.040	0.2196	0.080	0.1908	0.120	0.1620
	70	38° 0′		0.1622		0.1522		0.1322		0.1122
	80	40° 43′		0.0993		0.0932		0.0810		0.0688
	45	25° 25′		0.3660		0.3440		0.3000		0.2560
	50	27° 20′		0.3225		0.3025		0.2625		0.2225
50	60	30° 45′	0.020	0.2356	0.040	0.2211	0.080	0.1921	0.120	0.1631
	70	33° 33′		0.1648		0.1546		0.1342		0.1138
	80	35° 59′		0.1020		0.0958		0.0834		0.0710
	45	18° 48′		0.3665		0.3445		0.3005		0.2565
	50	20° 6′		0.3238		0.3038		0.2638		0.2238
60	60	22° 45′	0.020	0.2371	0.040	0.2225	0.080	0.1933	0.120	0.1641
	70	24° 53′		0.1677		0.1573		0.1365		0.1157
	80	26° 45′		0.1060		0.0995		0.0865		0.0735
	45	12° 20′		0.3670		0.3450		0.3010		0.2570
	50	13° 13′		0.3250		0.3050		0.2650		0.2250
70	60	15° 0′	0.020	0.2395	0.040	0.2251	0.080	0.1963	0.120	0.1675
	70	16° 27′		0.1701		0.1596		0.1386		0.1176
	80	17° 43′		0.1095		0.1027		0.0891		0.0735
	45	6° 2′		0.3700		0.3476		0.3028		0.2580
	50	6° 33′		0.3260		0.3058		0.2654		0.2250
80	60	7° 26′	0.020	0.2401	0.040	0.2257	0.080	0.1969	0.120	0.1681
	70	8° 10′		0.1730		0.1622		0.1406		0.1190
	80	8° 48′		0.1129		0.1059		0.0919		0.0779

The lands on the teeth of any milling cutter or reamer are invariably finally formed in the grinding operation, but they can be—and usually are—initially formed in the operation of milling the flutes or grooves between the teeth. This reduces the duration and cost of both the milling and the grinding operations. This case is illustrated in Fig. 2, where angle a represents the angle of elevation of the indexing or dividing head. It could be conceived, however, that the fluting or grooving cutter and the cutter or reamer blank were so arranged with respect to each other that the cutter penetrated the blank to such a depth that each tooth was formed in the fluting operation with a sharp edge which possessed none of the characteristics of a land. This case is illustrated in Fig. 3, where the angle of elevation of the indexing or dividing head is represented by a. A comparison of Figs. 2 and 3 will show a marked difference between the two cases. In the first case, the bottom of the flute or groove does not pass through the apex of the cone of which the cutter or reamer blank is a frustum; in the second case, it does. It does not follow as a

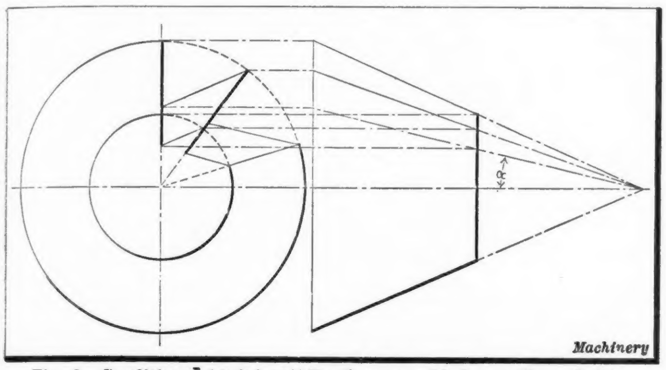


Fig. 3. Conditions obtaining if Tooth were milled to a Sharp Point

corollary, however, that, for similar conditions and dimensions (with the exception of the width of the land), the angles of elevation for the two cases are different, since it can be very readily demonstrated that the width of the land in any case has no influence upon the angle of elevation of the dividing head. This being the case, it is of no material importance which of the cases is considered for determining this angle; we shall, however, take the latter case (that is, the one involving no land-width), as it is the simpler of the two to treat.

There are two ways in which the angle of elevation can be determined. The first is the direct method, by means of which the value of a is calculated without any intermediate steps or operations. It is, however, an exceedingly complicated and cumbersome method, and not nearly as simple as the second one in its application. The second method involves three separate steps or operations: 1. The determination of the

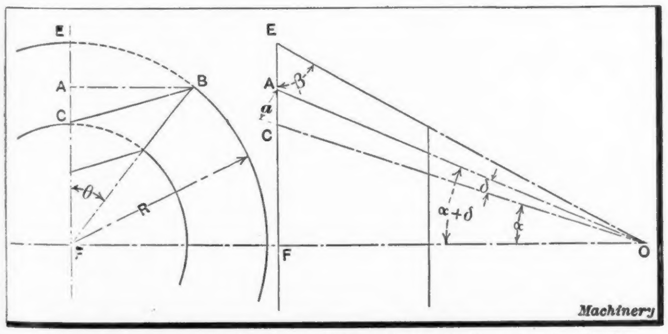


Fig. 4. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

value of the angle $(\alpha + \delta)$, Fig. 4; 2. The calculation of the angle δ in the same figure; 3. The obtaining of the difference between these two angles.

The conditions of the problem are indicated in Fig. 4, in which O represents the vertex of the cone of which the blank is a part or frustum; FE and FB represent the radius of the large end of the blank and are, therefore, equal to each other; CO represents the bottom of the flute produced to the vertex O; and ECB represents the flute at the large end of the blank.

Let R = the radius of large end of blank,

θ = tooth-angle of the blank (this angle is equal to $360 \div$ number of teeth to be milled in blank, the teeth being supposed to be spaced uniformly around the periphery of the blank),

β = angle of blank (this angle is measured as indicated in Fig. 4),

γ = angle of fluting cutter (this being assumed to be a single-angle cutter),

α = angle of elevation of dividing head.

Then $FA = FB \cos\theta = R\cos\theta$, and

$$\tan(\alpha+\delta) = \frac{FA}{FO} = \frac{R\cos\theta}{FO}.$$

Now, $\frac{FO}{FE} = \tan\beta = \frac{FO}{R}$; therefore $FO = R\tan\beta$. Hence

$$\tan(\alpha+\delta) = \frac{R\cos\theta}{R\tan\beta} = \frac{\cos\theta}{\tan\beta} \qquad (1)$$

Since θ and β are known for any particular case, the values of $\cos\theta$ and $\tan\beta$ can be obtained from a table of trigonometrical ratios, and the value of $\tan(\alpha+\delta)$ calculated, and the value of the angle $(\alpha+\delta)$ obtained.

The second part of the process of finding the value of the angle of elevation of the head involves the determination of angle δ. In Fig. 4 $\sin\delta = \frac{a}{AO}$. Now, from an examination of Fig. 5, which is a section normal to the bottom of the flute or groove and passing through line AB, and by comparing it with Fig. 4, we see that $a = AB\cot\gamma$. Further,

$$AO = \frac{AF}{\sin(\alpha+\delta)} = \frac{AB}{\sin(\alpha+\delta)\tan\theta}. \text{ Therefore}$$

$$\sin\delta = \frac{AB\cot\gamma}{\dfrac{AB\cot\theta}{\sin(\alpha+\delta)}} = \cot\gamma\tan\theta\sin(\alpha+\delta) \qquad (2)$$

This expression will give the value of $\sin\delta$, since at this stage all the other quantities involved are obtainable from the given data, and from $\sin\delta$ the value of angle δ is obtained.

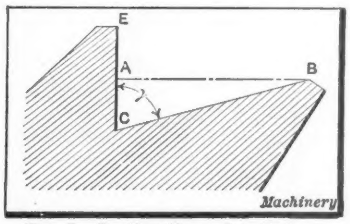


Fig. 5. Section Normal to Bottom of Tooth

It will now be observed that the values of the angles $(\alpha + \delta)$ and δ can be calculated from the furnished data, and that their difference is the angle α required (the angle of elevation of the dividing head).

As the expressions above, however, are obviously altogether too cumbersome to admit of their use in ordinary machine shop practice, the accompanying Data Sheet Supplement has been prepared, giving the values of the angles of elevation of the dividing head for a large number of combinations of number of teeth to be milled in blank, angle of blank, and angle of fluting cutter. For any combination not provided for, the "simple proportion" method of determining the values of angle α from the values given in the tables will usually give a result sufficiently close for practical purposes. To illustrate this point, let us take the case of a cutter blank in which 15 teeth have to be milled, the angle of the blank (β) being 65 degrees, and the angle of the fluting cutter (γ) being 55 degrees. Consulting the tables and applying the "simple proportion" method in steps, we find that α = 15 degrees 58 minutes for this case, while if calculated by means of Equations (1) and (2), the value of the angle equals 16 degrees 3 minutes, the difference of 5 minutes being negligible, as it is not possible to set the dividing head spindle to within 10 minutes, in the majority of cases.

In addition to the angle of elevation of the dividing head, it is necessary to know the depth of cut required to form the width of land selected. This is also given in the accompanying Data Sheet Supplement. The mathematical deductions required to obtain the values given in the tables will be dealt with in the following.

TABLES VII AND VIII. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 20

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	51° 43′		0.3119		0.2904		0.2474		0.2044
	50	54° 18′		0.2688		0.2504		0.2136		0.1768
20	60	58° 59′	0.020	0.1897	0.040	0.1767	0.080	0.1507	0.120	0.1247
	70	62° 44′		0.1258		0.1172		0.1000		0.0828
	80	66° 0′		0.0692		0.0644		0.0548		0.0452
	45	43° 0′		0.3142		0.2927		0.2497		0.2067
	50	45° 15′		0.2744		0.2556		0.2180		0.1804
30	60	49° 30′	0.020	0.1960	0.040	0.1826	0.080	0.1558	0.120	0.1290
	70	52° 56′		0.1325		0.1234		0.1052		0.0870
	80	55° 55′		0.0766		0.0713		0.0607		0.0501
	45	34° 39′		0.3220		0.2999		0.2557		0.2115
	50	36° 47′		0.2779		0.2589		0.2209		0.1829
40	60	40° 30′	0.020	0.2008	0.040	0.1870	0.080	0.1594	0.120	0.1318
	70	43° 30′		0.1375		0.1281		0.1093		0.0905
	80	46° 7′		0.0823		0.0767		0.0655		0.0543
	45	30° 29′		0.3300		0.3076		0.2628		0.2180
	50	32° 37′		0.2829		0.2595		0.2227		0.1859
45	60	36° 9′	0.020	0.2028	0.040	0.1896	0.080	0.1607	0.120	0.1330
	70	38° 53′		0.1407		0.1311		0.1119		0.0927
	80	41° 19′		0.0846		0.0788		0.0672		0.0556
	45	27° 3′		0.3250		0.3026		0.2578		0.2130
	50	28° 47′		0.2820		0.2627		0.2241		0.1855
50	60	31° 51′	0.020	0.2051	0.040	0.1906	0.080	0.1616	0.120	0.1326
	70	34° 20′		0.1432		0.1334		0.1138		0.0942
	80	36° 31′		0.0879		0.0819		0.0699		0.0579
	45	20° 0′		0.3232		0.3010		0.2566		0.2122
	50	21° 15′		0.2831		0.2637		0.2249		0.1861
60	60	23° 36′	0.020	0.2079	0.040	0.1933	0.080	0.1649	0.120	0.1365
	70	25° 30′		0.1460		0.1360		0.1160		0.0960
	80	27° 10′		0.0920		0.0857		0.0731		0.0605
	45	13° 0′		0.3321		0.3093		0.2637		0.2181
	50	14° 0′		0.2860		0.2663		0.2269		0.1875
70	60	15° 36′	0.020	0.2122	0.040	0.1972	0.080	0.1672	0.120	0.1372
	70	16° 54′		0.1479		0.1377		0.1173		0.0969
	80	18° 0′		0.0952		0.0887		0.0757		0.0627
	45	6° 30′		0.3250		0.3030		0.2590		0.2150
	50	6° 56′		0.2871		0.2675		0.2283		0.1891
80	60	7° 45′	0.020	0.2106	0.040	0.1962	0.080	0.1674	0.120	0.1386
	70	8° 25′		0.1480		0.1379		0.1177		0.0975
	80	8° 59′		0.0953		0.0888		0.0758		0.0628

Number of Teeth in Cutter to be Fluted = 24

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	55° 0′		0.2531		0.2321		0.1901		0.1481
	50	57° 12′		0.2169		0.1989		0.1629		0.1269
20	60	61° 2′	0.020	0.1522	0.040	0.1396	0.080	0.1144	0.120	0.0892
	70	64° 7′		0.1000		0.0918		0.0754		0.0590
	80	66° 50′		0.0540		0.0495		0.0405		0.0315
	45	46° 5′		0.2549		0.2339		0.1919		0.1499
	50	48° 0′		0.2202		0.2020		0.1656		0.1292
30	60	51° 30′	0.020	0.1563	0.040	0.1434	0.080	0.1176	0.120	0.0918
	70	54° 20′		0.1045		0.0959		0.0787		0.0615
	80	56° 48′		0.0590		0.0541		0.0443		0.0345
	45	37° 39′		0.2559		0.2348		0.1926		0.1504
	50	39° 15′		0.2230		0.2046		0.1678		0.1310
40	60	42° 20′	0.020	0.1598	0.040	0.1466	0.080	0.1202	0.120	0.0938
	70	44° 48′		0.1083		0.0994		0.0816		0.0638
	80	46° 59′		0.0629		0.0577		0.0473		0.0369
	45	33° 45′		0.2569		0.2357		0.1933		0.1509
	50	36° 15′		0.2251		0.2065		0.1693		0.1321
45	60	37° 50′	0.020	0.1620	0.040	0.1486	0.080	0.1218	0.120	0.0950
	70	40° 7′		0.1102		0.1011		0.0829		0.0647
	80	42° 7′		0.0653		0.0599		0.0491		0.0383
	45	29° 40′		0.2578		0.2366		0.1942		0.1518
	50	30° 52′		0.2270		0.2082		0.1706		0.1330
50	60	33° 25′	0.020	0.1639	0.040	0.1503	0.080	0.1231	0.120	0.0959
	70	35° 30′		0.1120		0.1027		0.0841		0.0655
	80	37° 20′		0.0664		0.0610		0.0502		0.0394
	45	21° 50′		0.2602		0.2386		0.1954		0.1522
	50	22° 52′		0.2276		0.2090		0.1714		0.1340
60	60	24° 50′	0.020	0.1650	0.040	0.1514	0.080	0.1242	0.120	0.0970
	70	26° 27′		0.1136		0.1042		0.0854		0.0666
	80	27° 50′		0.0690		0.0633		0.0519		0.0405
	45	14° 25′		0.2610		0.2394		0.1962		0.1530
	50	15° 5′		0.2290		0.2102		0.1726		0.1350
70	60	16° 25′	0.020	0.1676	0.040	0.1537	0.080	0.1259	0.120	0.0981
	70	17° 33′		0.1147		0.1053		0.0865		0.0677
	80	18° 30′		0.0700		0.0643		0.0529		0.0415
	45	7° 5′		0.2682		0.2460		0.2016		0.1572
	50	7° 30′		0.2300		0.2111		0.1733		0.1355
80	60	8° 10′	0.020	0.1684	0.040	0.1545	0.080	0.1267	0.120	0.0989
	70	8° 43′		0.1177		0.1079		0.0883		0.0687
	80	9° 13′		0.0715		0.0657		0.0541		0.0425

In the foregoing the formulas required for calculating the angle to which to set the dividing head when milling angular cutters or taper reamers are given. The question of determining the depth of the cut required for any given width of land will now be dealt with. As will be shown in the following, the depth of cut required depends, among other factors, upon the selected width of land, and, therefore, a change in the depth of cut will cause a land of another width to be formed.

The conditions of this part of the problem are represented in Fig. 6. In this figure, W represents the width of the land. Now, as has already been explained in previous articles by the present writer in MACHINERY, the width of the land formed in the grinding operation is a straight-line quantity, but W in the figure is a circular width (that is, it is measured on the circumference of the blank circle). In the majority of cases, however, the difference between the two quantities is of infinitesimal dimensions and may, therefore, be neglected. Hence, in our treatment of the case, we shall assume that the two are equal. This circular land-width W (measured, in this

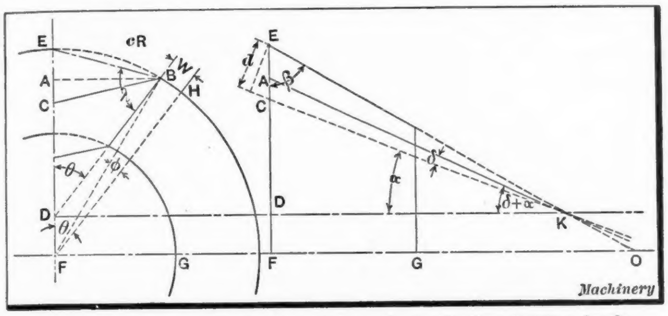


Fig. 6. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

instance, on the circumference of the circle representing the large end of the blank) subtends an angle ϕ at the center of the circle, the value of ϕ, in degrees, being $\frac{W}{R} \times 57.3$. The chord cR is the chord which subtends the angle $(\theta - \phi)$ at the center of the circle, the coefficient c being the length of this chord when $R = 1$. The line AB has already been referred to in connection with Figs. 4 and 5; d is the depth of cut required, and is measured in a direction normal to the bottom of the flute and from the edge of the blank.

An examination of Fig. 6 will show that:

$$d = EK \sin \{ 90 - (\alpha + \beta) \} = EK \cos (\alpha + \beta) \quad (3)$$

Now, $EK = \frac{ED}{\cos \beta}$, and $ED = \frac{cR \sin \lambda}{\sin \theta}$. But $\lambda = \left(90 - \frac{\theta + \phi}{2}\right)$; hence, $\sin \lambda = \sin \left(90 - \frac{\theta + \phi}{2}\right) = \cos \frac{\theta + \phi}{2}$. Therefore:

$$EK = \frac{cR \cos \frac{\theta + \phi}{2}}{\cos \beta \sin \theta}, \text{ and}$$

$$d = \frac{cR \cos \frac{\theta + \phi}{2} \cos (\alpha + \beta)}{\cos \beta \sin \theta} = KR \quad (4)$$

in which

$$K = \frac{c \cos \frac{\theta + \phi}{2} \cos (\alpha + \beta)}{\cos \beta \sin \theta}$$

and is the depth of cut required for a blank having unit radius.

To make this expression of practical utility, the values of K corresponding to the combinations of number of teeth N, and angles β and γ selected in the case of the angle of elevation of the dividing head, and several values of $\frac{W}{R}$ are given in Tables V, VI, VII and VIII, along with the angles of elevation of the head. Intermediate values (that is, values not covered by the combinations adopted in these tables, are obtainable within very close limits by means of the "simple proportion" method, as in the case of the angle of elevation of the head.

To illustrate the application of this method, let us take the case of a cutter blank in which 20 teeth have to be milled, the angle of the blank (β) being 45 degrees, and the angle of the fluting cutter (γ) being 60 degrees. Let the selected value of $\frac{W}{R}$ be 0.030. Then the depth for unit radius, when $\frac{W}{R} = 0.020$, equals 0.203 inch; and when $\frac{W}{R} = 0.040$, the depth equals 0.190 inch. Hence, when $\frac{W}{R} = 0.030$, the depth for unit radius equals $\frac{0.203 + 0.190}{2} = 0.1965$ inch.

The radius of the blank is invariably made a trifle larger than the radius of the finished cutter or reamer in order to allow for grinding after hardening, in which case, theoretically, it is necessary to make an allowance for the difference between the two radii in the expression giving the depth of cut. The modified expression is:

$$d = KR + (R_1 - R) \cos \alpha$$

in which R_1 = the radius of the large end of the blank, and R = the radius of the large end of the finished cutter or reamer.

* * *

METHOD OF PRODUCING SOUND INGOTS

The trouble experienced by railroads with broken rails, especially in countries where low temperatures prevail in winter, has demonstrated the necessity of producing sound rails. To produce sound rails means that the ingots from which the rails are made must also be quite sound and free from piping, segregation and blow-holes. Unless the ingots fulfill these requisites, trouble is bound to be experienced with the rails rolled from them.

The defects mentioned are caused by the conditions that existed in the ingot during the cooling process. Trouble from piping is caused by unequal contraction of the metal during cooling. This is due to the fact that the outer sections solidify first. Solidification continues little by little, the center being the last to reach the solid form. This means that an unequal degree of contraction takes place in the ingot, and as the space made void by this contraction is filled by liquid metal flowing down from the top, a cavity or "pipe" is formed in the upper section.

It is an established fact that defective ingots cannot be rolled into sound rails. The method of doing away with defects from piping employed by Sir Robert Hadfield and described in a paper read before the September 1912 meeting of the Iron and Steel Institute, consists of placing charcoal or other combustible material on top of the ingot mold after it has been filled. A layer of cupola slag is placed between the charcoal and the molten steel in order to protect the latter from the oxidizing effect of a blast of air which is directed on top of the ingot to facilitate the combustion of the charcoal. The ingot mold is fitted with a sand top, holding a supply of metal which is kept in a molten condition by the heat generated by the charcoal. This molten metal descends in the mold as contraction takes place and eliminates any tendency toward piping which would otherwise result from the contraction that takes place during cooling. The addition of small quantities of metallic aluminum tend to "quiet the metal", that is to say the aluminum combines with oxygen which is present and carries it away in the form of slag. This reduces the tendency toward the formation of blow-holes. Fortunately it has been found that a remedy which overcomes the tendency toward piping also tends to check the formation of blow-holes or segregated sections. Consequently ingots produced according to this process are particularly free from defects, and the additional expense is more than offset by the reduction in the quantity of material which must be discarded during subsequent processes.

RELATION OF PRICE OF TOOL STEEL TO MANUFACTURING COSTS

BY D. G. CLARK*

A short time ago we received an order from an up-to-date concern, bearing this notation: "This steel, which costs twice as much, must give at least double the production of our present steel in the operation in which it is to be used, otherwise it will be returned." The buyer in this concern was one of the men who believe that if one tool steel costs fifty per cent more per pound than another, it must do fifty per cent more work to justify the price. As a matter of fact, if one steel does five per cent more work than another it is well worth fifty per cent more per pound on all usual operations. There are many ways of proving this. One is to take any machine in the shop and learn the relation of tool cost to total costs. For illustration, we have selected a lathe using tools made from 1½ by ¾ inch steel. How much high-speed steel is used a day? Our observations, estimates and averages show that the daily consumption is one-twelfth pound of high-speed steel on the average lathe, doing fairly hard work at a good speed. This is based on work requiring the tool to be ground five or six times a day. If the tools cut all day on one grinding it indicates that they are cutting considerably below capacity, although this is sometimes necessary owing to local conditions. The one-twelfth pound daily consumption of steel is arrived at in the following way:

High-speed Steel used Daily on 20-inch Lathe

Size of tool: 1½ by ¾ inches. Average number of grindings: six per day.

Steel ground away each grinding......	1/32 inch
Steel ground away each day (six grindings)	3/16 inch
Steel ground away each week (six days)	1 inch (approx.)

Then the tool needs redressing. In redressing and retempering, a small piece of steel is cut off. Making liberal allowance, this waste is about one-half inch of steel.

The waste of steel in redressing is.............	½ inch
The amount of steel ground away is (see above)	1 inch
The weekly consumption of steel...............	1½ inches

One-and-one-half lineal inches of 1½ by ¾ inch high-speed steel weighs one-half pound. The daily consumption, therefore, is one-sixth of one-half pound, or one-twelfth pound.

The Daily Cost of Tool Steel

On the basis of one-twelfth pound steel consumption per day, if equal quantities were used:

High grade high-speed steel at 71 cents per pound costs, per day..	$0.06
Cheap high-speed steel at 48 cents per pound costs, per day	.04
Increased first cost of higher priced steel, per day......	$0.02

The Cost of Operating

On a lathe such as we are using for illustration,

The machinist's hourly rate, about....................	$0.36
The overhead (including power).......................	.24
The total hourly rate................................	$0.60
The day rate (eight hours)...........................	$4.80

The Value of the Product

If the man operating the lathe which we are using for illustration turns out 100 units of work daily, each piece costs the manufacturer 1/100 of $4.80 or 4.8 cents, and just that much value is produced. If the higher priced steel enables the machinist to turn out one piece more daily, thus increasing the output only one per cent, we have the following results:

Value of one extra piece produced....................	$0.048
Increased first cost of the steel......................	.020
Net daily profit on one per cent increase.............	$0.028

In this case a one per cent increase would warrant buying a good grade of steel costing fifty per cent more than cheap steel.

With a steel like "Blue Chip," for example, increases in production as high as fifty per cent or one hundred per cent are often secured, but the object of this article is to show that a five per cent increase in production justifies paying much more than a fifty per cent increase in first cost.

Taking the same illustration from another point of view: With the higher priced steel at 71 cents per pound,

The man's time per day..............................	$2.88
The "overhead" per day..............................	1.92
Steel per day.......................................	0.06
Daily total...	$4.86

With cheap steel at 48 cents per pound,

The man's time per day..............................	2.88
The "overhead" per day..............................	1.92
Steel per day.......................................	0.04
Daily total...	$4.84

The total daily cost has been increased less than one-half of one per cent; one-half of one per cent of $4.84=2.4 cents. Therefore if the higher priced steel does one-half of one per cent more work, it is the cheapest, although the price per pound may be fifty per cent higher than the steel formerly used.

Saving in Grinding

There is another point of view from which the price of tool steel should be considered, and that is the saving in grinding. Some tool steel users think that if the steel costs twice as much, it must require grinding only one-half as many times, but in the foregoing illustration, if one grinding is saved in two days, it justifies paying fifty per cent more for the steel. We arrive at this conclusion through the following: We have found that sixty cents an hour is a conservative estimate of the cost of a man's time and the overhead expense. On this basis every grinding which requires about five minutes means a loss of time and production worth five cents. The excess first cost of steel at seventy-one cents, as compared with a forty-eight-cent steel on the machine we are using for illustration, amounts to two cents a day. Therefore, if tools made from the higher priced steel save one grinding in two days, they warrant an increase of fifty per cent in the price per pound.

In addition to the profit and saving resulting from increased production and fewer grindings, there are also secondary savings to be considered. For instance, tools made from the higher priced steel will require redressing and rehardening less frequently, and the cost department knows what this means in the way of economy. Another saving results through a reduction in the amount of steel used. This has not been brought into our figures, but it should be considered in discussing tool steel costs. Less of the high-priced steel will be required than is the case where cheap steels are used.

Another important saving that is often forgotten, and which cannot be computed, is the time saved on break-down or emergency jobs. There are times in many shops when the management would gladly pay as much as the monthly tool steel bill to save an hour on a repair part, the lack of which holds up a large shipment, or stops work throughout the shop.

A number of minor savings have not been mentioned, but they are not needed to prove the wisdom of paying fifty per cent more for a steel which does five per cent more work. In conclusion, it may be stated that this method of considering tool steel costs may be applied on any machine, regardless of the kind of steel used. In nearly every case the higher priced steel, whether in ordinary tool steel grades or in high-speed steel grades, will be found cheapest if it brings about even a slight increase in the efficiency of cutting tools.

[The indirect relation of the cost of the tools of production to the cost of production so clearly set forth by Mr. Clark in the foregoing, applies all along the line. The first cost of a machine is of little importance in comparison with its productive capacity during its lifetime. A lathe costing $1000 may in the course of ten years, earn $10,000 for the shop in which it is used, while another of the same nominal capacity but of superior design and workmanship, costing say $1100, might earn $12,500 in the same period, or sufficiently more than the other to wipe out the original cost and the interest on the investment.—EDITOR.]

* * *

Many a carefully guarded trade secret is a huge joke. Ostriches can hide from each other, you know, by all thrusting their heads into the sand.—*Webster Method.*

* Address: E. S. Jackman & Co., Agents, Firth-Sterling Steel Co., 710-14 West Lake St., Chicago, Ill.

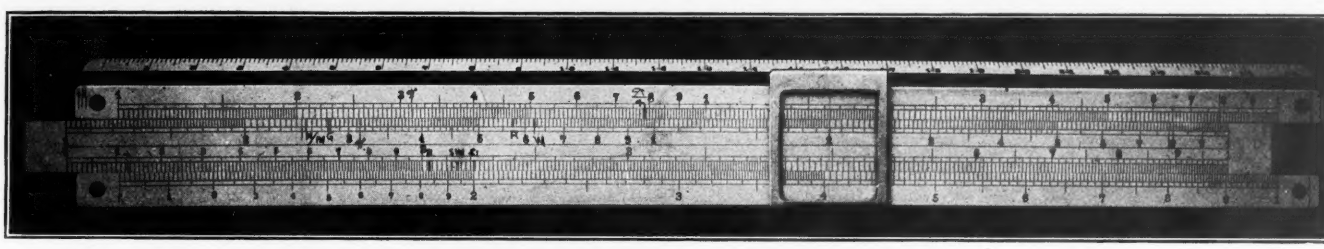
SLIDE-RULE CONSTANTS

BY A. LAURENS

The illustration which appears in connection with this description shows the writer's slide-rule on which several useful constants have been laid out. These constants refer to quantities which are frequently used by designers and estimators, and their use enables the weight of disks or rings of various metals to be rapidly determined. The metals in question are indicated on the rule by the following letters laid out on scale 3 of the slide-rule: *S*, for steel; *WI*, for wrought iron; *CI*, for cast iron; and *B* for brass. On the same scale there is marked a constant *V* that is used to determine the volume of disks or rings. In using the rule, on which these constants are marked, to obtain the weight of a disk or ring of the metal in question, it is only necessary to bring the symbol for the particular metal over the figure for diameter on scale 4 of the rule. The required weight or volume is then read on scale 1 of the rule above the thickness of the disk on scale 2. These results will be found accurate enough for almost any class of work and this method of calculation is far more rapid than the customary arithmetical process.

To illustrate the use of these constants, the reader is referred to the setting of the rule shown herewith. Here it will be seen that the constant for cast iron is set for a disk 20 inches in diameter. To get the weight of such a disk 3 inches thick, the reading of 245 pounds is obtained on scale 1 directly above the figure 3 on scale 2. To obtain the volume of a disk 20 inches in diameter and 3 inches thick, the constant *V* on scale 3 would be brought up to the figure 20 on scale 4. The volume of 944 cubic inches is then read on scale 1 over the figure 3 on scale 2. For the sake of checking the accuracy of this method, the same problem is carried through in the ordinary way. The weight of this disk will be $\frac{\pi D^2}{4} \times$ thickness $\times$ weight per cubic inch of cast iron. The weight of a cubic inch of cast iron is 0.26 pounds and substituting the other known values, a figure of 245.3 pounds is obtained for the weight of the disk. The volume of the disk is $\frac{\pi D^2}{4}$ $\times$ thickness $=$ 943 cubic inches. These figures correspond closely enough for all practical purposes with the one obtained by using the constants. Even allowing that the arithmetical method can be worked out on a slide-rule, it will be granted that such a method takes longer than the one where the constants are used. With the constants, only one setting of the rule is required, and after this setting has been made any number of weights or volumes can be read off at once. In obtaining the weight or volume of a ring of metal, the process has to be repeated, and one reading subtracted from the other, the method being that of finding the difference in weight or volume between two disks of metal of the outer and inner diameters of the ring.

It will be seen that several other constants have been laid out on scale 2 of the rule. These are $M/M = 25.4$ which represents the number of millimeters in an inch. $G = 277$, which is the number of cubic inches in a gallon. This is the number of cubic inches in the British Imperial gallon and for the use of American engineers it would be better to give this figure a value of 231, which represents the number of cubic inches in the standard U. S. gallon. $R = 57.3$, which is the number of degrees in a radian. $W = 62.3$, which is the number of pounds per cubic foot of water. These are constants which engineers frequently need to use, and having them marked directly on the face of the rule saves a lot of time.



Slide-rule laid out with Some Useful Constants

HOW A LITTLE SHOP GREW

BY A. P. PRESS

One evening we were out on the back door-step, and Billy, our next-door neighbor, came to the fence and called us over. Now, we had known Billy a long while. He was a pretty good fellow. He didn't drink or use any red paint, had a wife and two kids who, although they used to stone our cat once in a while, were pretty good boys after all. Billy had learned his trade with us some six years ago, and then he got out and went with the B. & H. Co., and had been with them ever since, and while we knew that he had been tinkering down cellar we were kind of surprised at what he wanted.

"Say, Mr. Press, haven't you got an attic over in your shop there that isn't working very hard?"

"Yes, Billy, I guess so."

"Well, I've been doing a little manufacturing on the side the last year. In the summer time I did it down cellar, and last winter I moved it up in the bed-room. Now it's getting kind of thick, and I thought perhaps you could let me have that back attic, and put all the junk up there."

"That's all right, Billy," we said. "Go ahead and put it in. You probably won't need any power, but if you do we'll cut a hole through the floor and run a belt up. What do you want to run?"

"Oh, nothing much; just a power press and a drill press, and possibly a lathe."

"Well, Billy, go ahead. The attic is not very big, but if you can stand it we can."

So Billy went ahead. He moved in one Saturday afternoon, and from then on there was more or less noise from the back attic that indicated that Billy was working. We didn't butt in on him, but when he had been there about six months we took a notion one evening to go in and see him, and we were surprised. He had a nice little lathe, drill press, power press and foot press, all in that 10 by 14 attic, and he was turning out some of the neatest little tool attachments we had ever seen.

"Well, Billy, where did you get those ideas?"

"Oh, I kind of picked them up, and put them through the patent office, and I suppose they are mine now."

We went away and let Billy alone. Six months more passed by, and Billy came around one night and said:

"Well, Mr. Press, I guess I'll have to move out next month."

"Why, how's that?"

"Well, you see, it's kind of crowded, and so I'm going to build a little shop in the back-yard."

So Billy built his "little shop" (it was about 20 by 40 feet) and moved his tools in. There was a smart looking boy working steady every day, but Billy was only there evenings, for he still held his position with the B. & H., where he had risen to be master mechanic, and was drawing a good salary.

For a whole year we watched Billy nights and Saturday afternoons (the place was shut tighter than a drum Sundays) and one Monday we noticed Billy hanging around the place all day. The next morning we happened to see him over the fence, and sang out to him.

"How's that, aren't you working this week?"

"No," said Billy, "not this week. You see it was like this. The orders were piling in on me for those little tool attachments, and I got so many ahead that I was kind of worried. So I told them down to the factory that I wanted two weeks off, and while they put up an awful howl, I said it was either that or fire me. They didn't want to fire me, so they gave me the two weeks. I guess I will catch up in that time."

Two weeks passed, and we saw Billy again.

"Say, Mr. Press, you don't know where I could get a good man to take my job down to the B. & H., do you?"

"Why, what's the matter?"

"I thought I could catch up with my orders here in two weeks, but instead of that I'm farther behind than I was when I came out. So I went down and told them, and they put it up to me good and plenty that I either had to go back or else get them a man to take my job, so I'm looking for the other man."

Well, to make a long story short, Billy found the "other man." He has been out in the little shop nearly a year now, and it has been running 313 days. Sundays and Christmas are the only days that Billy doesn't work, and from the ink stains that I saw on Mrs. Billy's fingers the other day, I should say that she runs the bookkeeping end of the job.

We were in to see him not long ago (our power was shut down and we wanted to grind a chisel) and he had the nicest little shop that we have seen for a long time. It was crowded, and Billy says:

"I can't seem to get caught up on the work, and the only thing that I can see is to add on some floor space somewhere. I haven't much money, but I went and told all my customers just how it is, that I've got to turn my money over pretty often to make both ends meet, so as to take care of Mrs. Billy and the kids, and they have all done fine."

It doesn't take much of a vision to look into the future (not very far, either) and see Billy holding down an arm chair with a roll top desk, and with the business increasing to support the same.

Now, if any of you boys are planning to follow in Billy's footsteps, and want the secret of his success, it is very easy to get. It is work, work hard, and then work some more. We will try and keep tabs on Billy for at least a year or so more and tell you about him again. If you are a young man it will do you good. If you are an old fellow it wont hurt you any.

* * *

CROSS-SLIDE REAMING ATTACHMENT FOR THE CLEVELAND PLAIN AUTOMATIC

It is generally recognized that the plain type of automatic screw machine built by the Cleveland Automatic Machine Co., Cleveland, O., lends itself admirably to the rapid production of parts requiring the use of only one turret tool; hence in some shops this type of machine is confined to work requiring the use of one turret tool exclusively. The chief advantage gained in using the plain type of machine is that most of the idle movements common to the turret type are eliminated, thus cutting down the production time considerably.

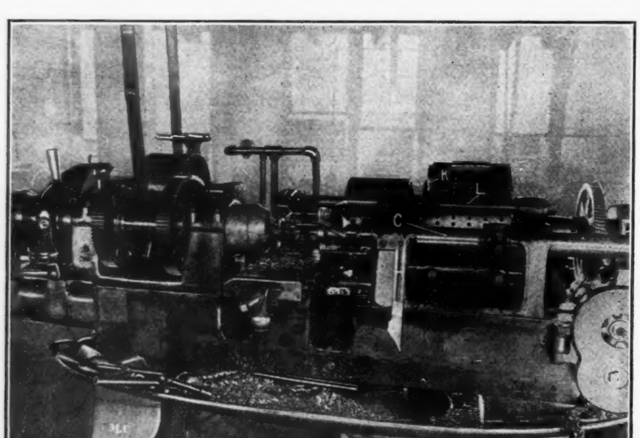


Fig. 1. Method of Gaging Work to Length

The piece shown in Fig. 2 is a good example of work, which with a little thought on the part of the designer can be produced economically on the plain type of machine. As can be seen, this piece, if made on the turret machine, would require three turret tools: stop, drill and reamer.

The method of "tooling" the plain machine for producing this piece is shown in Figs. 1 and 3. Here a drill A is held in a split holder B, the latter being retained in the tailstock spindle C. Enveloping the tailstock spindle is a collar D, which is provided with a notched lug fitting the bent end of the push-rod E.

The reamer F is held in a spindle G, which is a sliding fit in the bracket H clamped to the front cross-slide. Fastened to the front end of the spindle G, is an arm I, which extends down and is provided with a hole through which the push-rod E passes. This push-rod is threaded on the end passing through the arm, and is provided with adjusting nuts located on either side of the arm. These nuts are used for adjusting

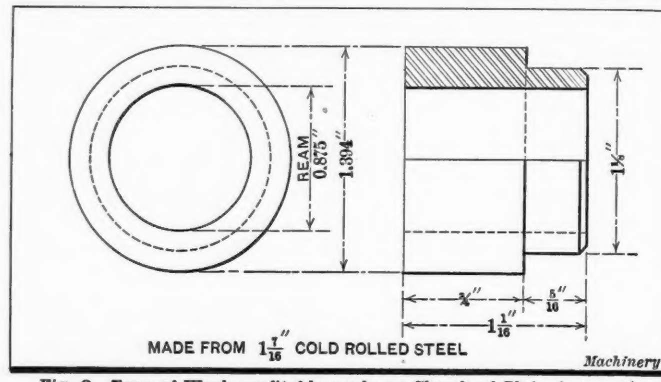


Fig. 2. Type of Work profitably made on Cleveland Plain Automatic

the push-rod, so that its bent end will always enter the slot in the collar D, the coil spring S always returning this rod to the same position, ready to be engaged again when the cross-slide is advanced to bring the reamer into position.

In operation, the stock is fed out, and is gaged to length by the swinging stop J, which is operated by a cam block K in Fig. 1. This stop is returned to the "up position" by a twisted spring L. After the stock is gaged to length, the cross-slide is advanced and the work turned to the required shape and diameter by a flat forming tool M. The cross-slide

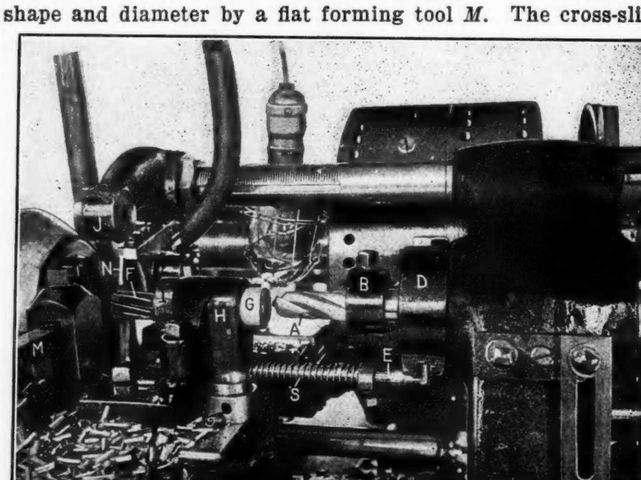


Fig. 3. The Method of "Tooling" the Machine

then retreats, and the tailstock spindle carrying the 0.865-inch drill A is advanced, producing the hole.

The tailstock spindle now retreats into the position shown in Fig. 3; then the cross-slide advances and the bent end of the push-rod engages with the slot in the collar. The tailstock spindle then advances and as it is connected with the reamer holder by the push-rod, it follows that the 0.875-inch reamer is forced into the work.

Before the reamer has finished cutting, the rear cross-slide is advanced, carrying the cut-off blade N, which severs the completed piece from the bar. While the work is being severed, the tailstock spindle recedes, and as it reaches the "back position", the push-rod is disconnected from the collar by the cross-slide dropping back, thus clearing the machine ready for this cycle of operations to be repeated.

The cams are timed on all of the various drums, so that each tool just clears, thus cutting down the idle time to a minimum. The work is rotated, in a forward direction, at 334 R. P. M., and it requires 84 seconds to complete one piece. The feeds given the various tools are:

Drill	0.008 inch per revolution,
Reamer	0.012 inch per revolution,
Form	0.003 inch per revolution,
Cut-off	0.003 inch per revolution.

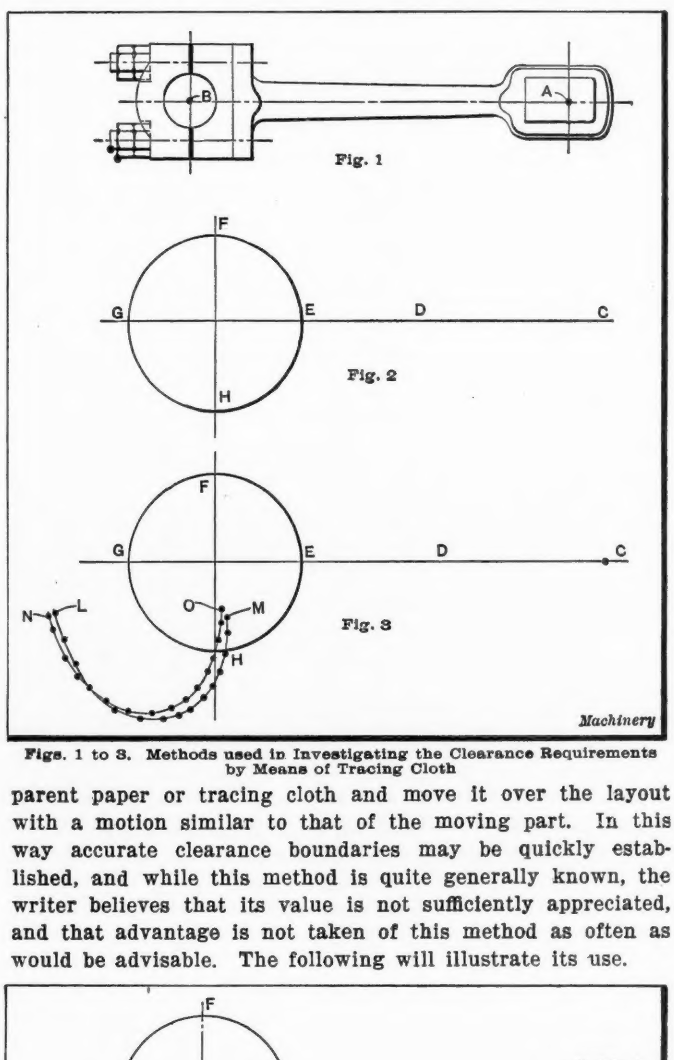
D. T. H.

SOME PROBLEMS SOLVED BY THE USE OF TRACING CLOTH

BY JOHN S. MYERS*

The designer sometimes wastes considerable time trying to determine whether he has allowed proper clearance for a moving part. The method of laying out the part in several different positions in an attempt to determine whether there is any interference is the longest way around. Some draftsmen draw a circle or a straight line which is termed the "clearance line" and to which they work. However, if properly developed, the actual clearance boundary is often a peculiar curve which differs considerably from a circle or a straight line. Methods of this kind often compel the erector to get the required clearance by chipping off ribs which are actually needed for strength. The cost is increased, the designer loses prestige, and there is annoyance all around.

The best and simplest way for investigating the clearance requirements is to roughly trace the moving part on transparent paper or tracing cloth and move it over the layout with a motion similar to that of the moving part. In this way accurate clearance boundaries may be quickly established, and while this method is quite generally known, the writer believes that its value is not sufficiently appreciated, and that advantage is not taken of this method as often as would be advisable. The following will illustrate its use.



Figs. 1 to 3. Methods used in Investigating the Clearance Requirements by Means of Tracing Cloth

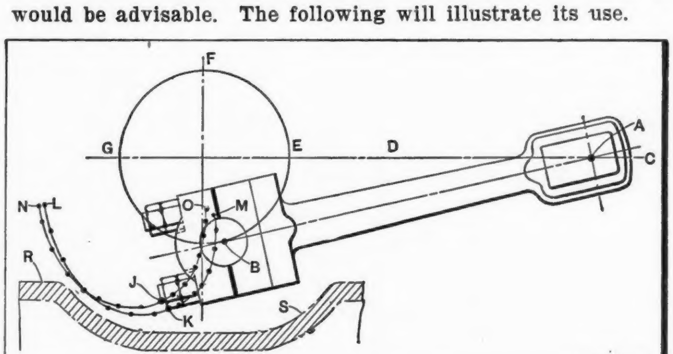


Fig. 4. The Clearance Determined

In Fig. 1 is shown a connecting-rod, the clearance for the crank-end of which is to be determined. First draw the lines indicated in Fig. 2 on the drawing paper. Here the line *CD* represents the path of point *A*, Fig. 1, while circle *EFGH* represents the path of point *B*. The connecting-rod in Fig. 1 is drawn on tracing cloth, and this may now be laid on top of the lines drawn on the drawing paper in Fig. 2, as indicated by Fig. 4. The connecting-rod on the tracing cloth is then moved about, point *A* being kept on the line *CD* and point *B* on the circle *EFG*. The points *J* and *K* then describe the clearance curves required at the further end. These can be pricked with a pin, and the curves *LM* and *NO* drawn through the points thus determined.

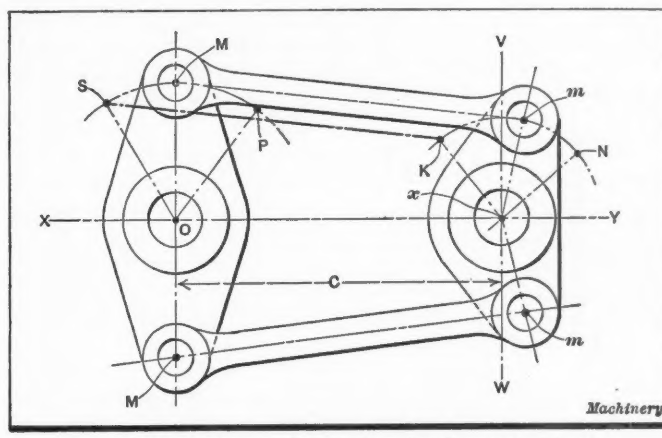
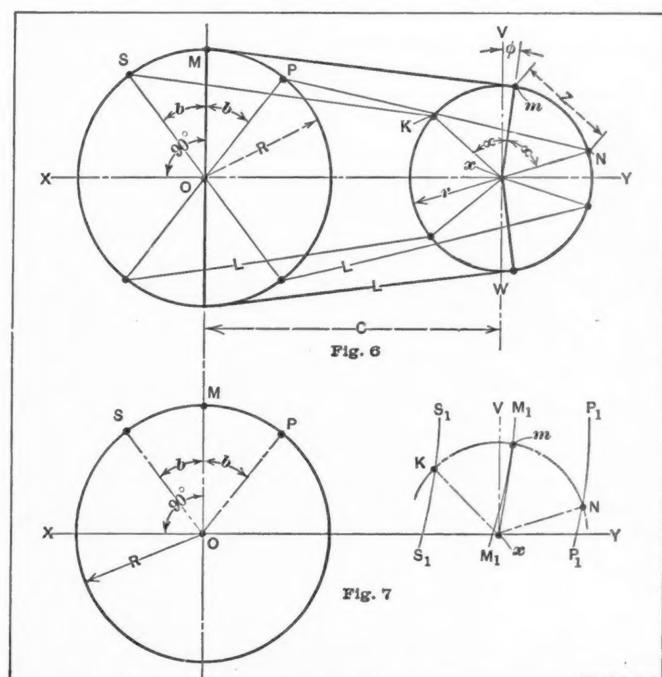


Fig. 5. A Mechanism involving a Complex Geometrical Problem

Another kink which can be made use of in connection with tracing cloth may be of interest. In making the blueprint from which Fig. 4 is reproduced, the writer did not wish to redraw the complete connecting-rod, yet it had to be shown to make the illustration complete. The method pursued was as follows: Fig. 1 was laid on top of Fig. 2 and the points of curves *LM* and *NO* pricked through and the curves drawn, which resulted in a drawing as shown in Fig. 3. The tracing in Fig. 1 was now placed on top of the tracing of Fig. 3, in correct position, and secured to it by adhesive tape; then a blueprint was made with sufficient extra exposure to allow for the double thickness of tracing cloth. The result then was a blueprint as indicated by the illustration shown in Fig. 4, to which, of course, was later added the dash-dotted lines showing the bed of the engine. The white spots left on the blueprint by the adhesive tape can be trimmed off and all evidence of the use of two tracings disappears. The contour of the bed casting *RS*, Fig. 4, is shown merely to indicate the reason for determining the clearance lines. The case chosen for illustration is a simple one, but the methods used are applicable to a wide range of work.



Figs. 6 and 7. Method of Solving the Geometrical Problem Involved in the Linkage in Fig. 5

The draftsman also sometimes meets with geometrical problems which would prove difficult to a professor of mathematics; yet he must find some quick and practical solution.

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By the use of a piece of tracing cloth the designer may often solve problems which mathematically are so involved as to seem almost hopeless. Such a case is given in the following.

In the linkage shown in Fig. 5, point M oscillates between points S and P, being actuated by point m moving along curve KmN. The object of the construction is to obtain a toggle joint action as point m approaches points K and N. A skeleton diagram is shown in Fig. 6. Point O is a fixed center, while, due to the angularity of the links Mm, point x moves on line XY, making center distance C a variable quantity. It was found that by putting point m at some angular position ϕ away from line VW, the movement of point x along line XY could be very materially reduced. The problem then was to determine a value for ϕ such that the movement of point x would be a minimum. The mathematical solution by the aid of calculus seemed very difficult, and after some experimenting it was decided that if center distance C was the same for the central position of the links Mm as for the extreme positions SK and PN, the movement of point x would be reduced to practically a minimum. The problem then reduced itself to this: R, r and L being known, find values of C, α, and ϕ such that C will be constant for positions OS, OM and OP of the linkage. The solution is as follows:

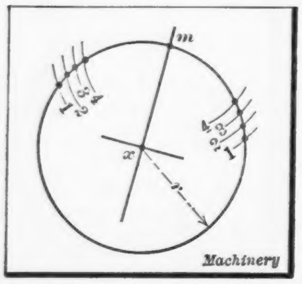

Fig. 8. The Lay-out made on Tracing Cloth

With radius R draw the circle in Fig. 7 and lay out the maximum angular movement b, thus locating points S, M and P. Draw XY through O perpendicular to OM. With radius L draw arcs S_1S_1, M_1M_1, and P_1P_1, S, M and P being their respective centers. On a transparent sheet draw a circle of radius r, x being its center, see Fig. 8. Choose some point on this circle, as m, and draw (with any convenient radius known to exceed Z in Fig. 6) the arcs 1, 1; then with slightly smaller radii draw arcs 2, 2; 3, 3; 4, 4; etc. Number these arcs 1, 2, 3, 4, etc.

Lay Fig. 8 on top of Fig. 7 and shift it around until, with point m lying on arc M_1M_1 and x lying on line XY, a position is found in which two similarly numbered points such as 1, 1, 2, 2, or 3, 3 lie upon arcs S_1S_1 and P_1P_1. When this position is found, prick through these numbered points, and also through points x and m; they will then represent the points similarly marked in Fig. 6. Mark these points found on Fig. 7, and draw lines xK, xm, xN, and xV, the latter being perpendicular to XY. Now $Ox = C$, angle $mxK = \alpha$, and angle $mxV = \phi$, the three unknown quantities which were to be found.

With a value of ϕ determined by the above method, the center distance C will be exactly the same in value for the links in position Mm, SK, or PN, but for any intermediate position, C will be slightly increased, or if angle b be exceeded, C will decrease.

There are a great number of difficult problems which may be solved in a somewhat similar manner by the employment of a little ingenuity. The writer's object in presenting the foregoing examples has simply been to call attention to the methods available and the value of a piece of tracing cloth.

* * *

DIMENSIONS OF LEAD PIPE

BY S. E. FERRY*

Some time ago I had occasion to use some lead pipe, and as it was necessary to know the inside as well as the outside diameters of the pipe (the space being limited) and the safe working pressures, I sought for the information in various books, but was surprised to find that the data was not available in the references at hand. After considerable hunting through the lead manufacturers' and plumbers' supply books, I was able to compile the accompanying table, which gives the outside diameter, inside diameter, thickness, weight per foot, approximate bursting pressure and safe working pressure of lead pipe from ⅜ inch to 2 inches inside diameter, in double, extra strong, strong, medium and light weights.

DIMENSIONS OF LEAD PIPE

Inside Diameter	Outside Diameter	Thickness	Weight per Foot		Approximate Bursting Pressure in Pounds per Square Inch	Safe Working Pressure in Pounds per Square Inch	Commercial Designations: Lead Pipe Manufacturers	Commercial Designations: Plumbing Supplies Catalogues*	Inside Diameter	Outside Diameter	Thickness	Weight per Foot		Approximate Bursting Pressure in Pounds per Square Inch	Safe Working Pressure in Pounds per Square Inch	Commercial Designations: Lead Pipe Manufacturers	Commercial Designations: Plumbing Supplies Catalogues*
Inch	Inch	Inch	Lbs.	Oz.					Inches	Inches	Inch	Lbs.	Oz.				
3/8	0.74	0.183	1	12	2150	430	AAA	D. E. S.	1	1.42	0.210	4	0	900	180	A	Strong
3/8	0.72	0.173	1	8	2000	400	AA	E. S.	1	1.36	0.180	3	4	775	155	B	Medium
3/8	0.66	0.143	1	4	1650	330	A	Strong	1	1.28	0.140	2	8	600	120	C	Light
3/8	0.63	0.128	1	0	1500	300	B	Medium	1	1.23	0.115	2	0	500	100	D	E. L.
3/8	0.58	0.103	0	12	1250	250	C	Light	1	1.17	0.085	1	8	400	80	E	Aqueduct
3/8	0.55	0.088	0	10	1050	210	D	E. L.	1¼	1.82	0.285	6	12	1000	200	AAA	D. E. S.
3/8	0.51	0.068	0	7	800	160	E	Aqueduct	1¼	1.75	0.250	5	12	900	180	AA	E. S.
7/16	0.66	0.111	1	0	1165	230	B	Medium	1¼	1.67	0.210	4	12	750	150	A	Strong
7/16	0.63	0.096	0	13	1000	200	C	Light	1¼	1.59	0.170	3	12	600	120	B	Medium
½	1.01	0.255	3	0	2000	400	AAA	D. E. S.	1¼	1.52	0.135	3	0	475	95	C	Light
½	0.87	0.185	2	0	1600	320	AA	E. S.	1¼	1.50	0.125	2	8	450	90	D	E. L.
½	0.84	0.170	1	12	1500	300	A	Strong	1¼	1.45	0.100	2	0	350	70	E	Aqueduct
½	0.76	0.130	1	4	1150	230	B	Medium	1½	2.11	0.305	8	8	900	180	AAA	D. E. S.
½	0.71	0.105	1	0	900	180	C	Light	1½	2.04	0.270	7	8	800	160	AA	E. S.
½	0.67	0.085	0	12	700	140	D	E. L.	1½	1.96	0.230	6	8	700	140	A	Strong
½	0.63	0.065	0	9	550	110	E	Aqueduct	1½	1.88	0.190	5	0	550	110	B	Medium
⅝	1.13	0.253	3	8	1700	340	AAA	D. E. S.	1½	1.82	0.160	4	4	475	95	C	Light
⅝	1.05	0.213	2	12	1500	300	AA	E. S.	1½	1.78	0.140	3	8	400	80	D	E. L.
⅝	1.02	0.198	2	8	1300	260	A	Strong	1½	1.75	0.125	3	0	350	70	E	Aqueduct
⅝	0.96	0.167	2	0	1150	230	B	Medium	1¾	2.42	0.335	10	0	850	170	AAA	D. E. S.
⅝	0.88	0.128	1	8	900	180	C	Light	1¾	2.26	0.255	8	8	650	130	AA	E. S.
⅝	0.80	0.088	1	0	600	120	D	E. L.	1¾	2.21	0.230	7	0	600	120	A	Strong
⅝	0.77	0.073	0	12	500	100	E	Aqueduct	1¾	2.15	0.200	6	0	500	100	B	Medium
¾	1.31	0.280	4	12	1900	380	AAA	D. E. S.	1¾	2.09	0.170	5	0	450	90	C	Light
¾	1.21	0.230	3	8	1400	280	AA	E. S.	1¾	2.03	0.140	4	0	375	75	D	E. L.
¾	1.16	0.205	3	0	1150	230	A	Strong	2	2.59	0.295	11	12	650	130	AAA	D. E. S.
¾	1.07	0.160	2	4	950	190	B	Medium	2	2.51	0.255	9	0	550	110	AA	E. S.
¾	1.01	0.130	1	12	750	150	C	Light	2	2.45	0.225	8	0	500	100	A	Strong
¾	0.94	0.095	1	4	550	110	D	E. L.	2	2.41	0.205	7	0	450	90	B	Medium
¾	0.91	0.080	1	0	450	90	E	Aqueduct	2	2.37	0.185	6	0	375	75	C	Light
1	1.59	0.295	6	0	1300	260	AAA	D. E. S.	2	2.26	0.130	4	12	275	55	D	E. L.
1	1.51	0.255	4	12	1100	220	AA	E. S.	......	......	......	......		......	......	......	......

The above table is based on 2240 pounds per square inch as the tensile strength of lead with 5 as a safety factor.

* D. E. S. = double extra strong; E. S. = extra strong; E. L. = extra light.

* Address: Care of Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

MULTIPLE-SHOULDER SHAFT TURNING ON THE CLEVELAND AUTOMATIC

An excellent example of multiple shoulder shaft turning in a Cleveland plain type automatic screw machine, is shown in Fig. 2. As can be seen, this shaft has six different diameters—three on each end. All of these various diameters are turned and the shaft completed in one operation. The end of the shaft next to the chuck is turned by a cross-slide tool arrangement carrying three turning tools, and operated transversely by the tailstock spindle, as shown in Figs. 1 and 3.

By referring to Fig. 1 it will be seen that a long connecting-rod *A* is held free to slide in an arm *B*, which is clamped to the tailstock spindle *C*. The rear end of this connecting-rod is threaded and furnished with check-nuts, the function of which will be explained later.

The cross-slide arrangement consists of a block *D*, fastened to the T-slot of the regular cross-slide and provided with a dovetailed top face to which an auxiliary top-slide *E* is fitted. This slide is furnished with a gib to compensate for wear, and is machined to retain the three tool-holders *F*, which can be adjusted so as to bring the shoulders on the work the required distance apart.

The end of the shaft facing the tailstock spindle is turned by a box-tool carrying three cutters and provided with roller

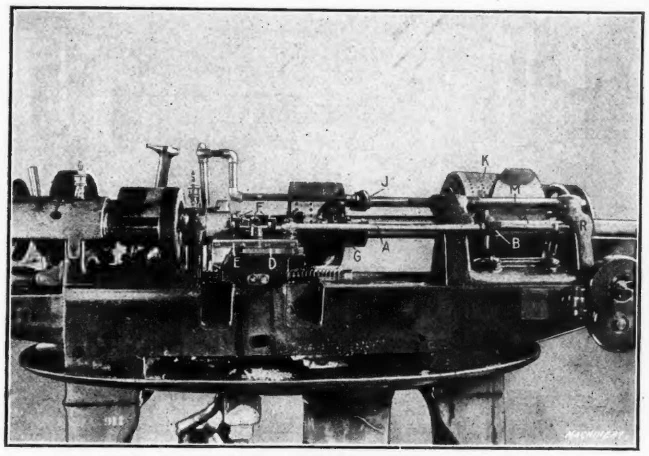

Fig. 1. Turning a Multiple Shoulder Shaft on the Cleveland Plain Automatic

supports to steady the work, as in Fig. 3. This box-tool *G* has a shank which is held in the regular manner in the tailstock spindle. The turning tools are retained in holders *I*, which can be adjusted along the body of the box-tool to the required positions.

In operation, the stock is fed out by a special cam on the stock-feed drum, and at the same time, the swinging stop *J* is brought down to gage the stock to length by a cam on drum *K*, see Fig. 1. When the chuck closes, the stop *J* is returned to the "up position" by the twisted spring *M*. The box-tool is now advanced, bringing the first tool *N*, Fig. 2, into operation, and at the same instant the regular cross-slide is advanced, feeding the tools *O*, *P*, and *Q* in to the proper depth. The cross-slide then retreats, and remains stationary with the tools clear of the work until the arm *B* approaches the check-nuts on the connecting-rod *A*. Just as this takes place, the regular cross-slide is again advanced, bringing the turning tools in to the correct depth.

The cross-slide turning tools which are now ready to turn the work to the required diameter, are advanced longitudinally on the work when the advancing arm *B* contacts with the check-nuts. The connecting-rod *A*, which acts as a link joining the tailstock spindle and auxiliary slide *E*, is pivotally connected to the latter. When the roll reaches the end of the lobe of the tailstock spindle operating cam, the spindle is returned by a spring, but does not carry the top-slide *E* with it until the arm *B* reaches the check-nuts *R*. By this time the regular cross-slide has withdrawn the tools from the work, thus clearing the machine for the finished piece to be severed from the bar by the cut-off blade *S*, held on the rear cross-slide.

The material from which this shaft is made is cold-rolled steel 1⅛ inch in diameter. The turning tools are operated

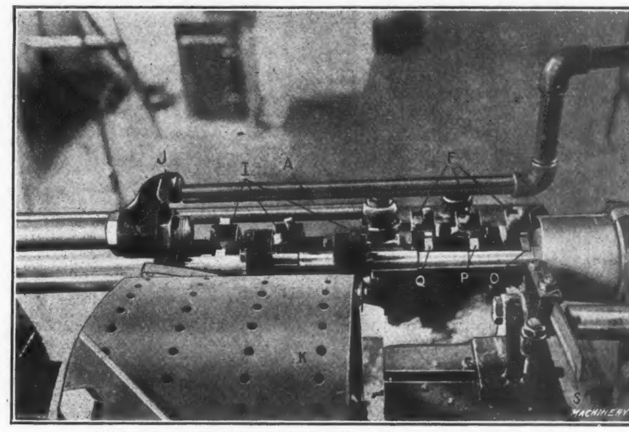

Fig. 3. Arrangement of Tools and of Adjustable Stop

at a surface speed of approximately 85 feet per minute, and finish the bar to the required diameter in one cut. The box-tool cutters when working alone, are advanced at a rate of 0.008 inch per revolution. The cross-slide tools when being fed in to the desired depth, receive a feed of 0.002 inch per revolution, and when the box-tool and cross-slide tools are working together, the rate of advance is 0.006 inch per revolution. The work is cut off with a feed of 0.004 inch per revolution. This shaft, which is 16 1/16 inches long, is completed in 5½ minutes. D. T. H.

* * *

LARGEST TESTING MACHINE IN THE WORLD

The issue of the *Engineering Record* for September 28 contains an interesting description of what is believed to be the largest testing machine in the world. It was designed by Mr. Tinius Olsen of Philadelphia, and has a capacity of 10,000,000 pounds. The machine was built for the structural materials testing laboratory of the United States Geological Survey, which is now part of the laboratory of the Bureau of Standards, located in Pittsburg, Pa., and was placed in operation on September 12. At this time, a number of members of the International Association for Testing Materials were present to witness its operation, and among their performances, a square brick column twelve feet high and four feet on each side, was broken; a load of 6,580,000 pounds was required to complete this test. The machine is designed with a capacity for testing pieces up to 60 feet in length and the distance between tension screws, is 6 feet. These dimensions fit the machine for testing exceedingly large columns as well as slabs, and by placing an extension table on the lower platen, the largest beams may be broken.

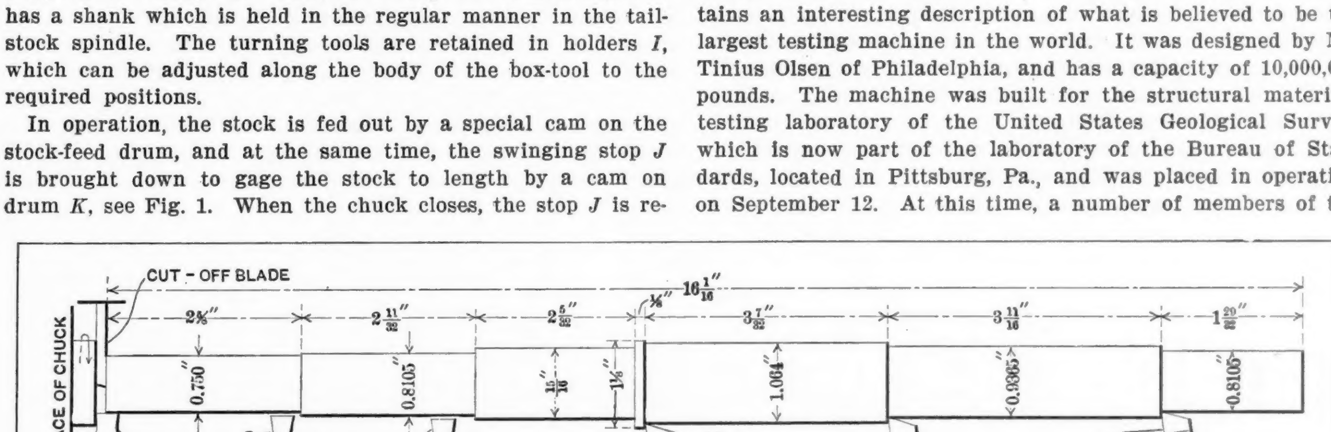

Fig. 2. Tools used in finishing the Shaft in One Operation

A SEMI-AUTOMATIC SLOTTING FIXTURE

BY J. H. HARRIS

The fixture to be described in this article is used by the Remington Typewriter Co. for the rapid and economical slotting of the part shown in Fig. 5. The fixture is semi-automatic in its action. It is carried on a shaft driven by the back-gears of a milling machine and all the operator has to do is to place the work between the jaws as they come around. As the fixture revolves, the work is fed against the cutter where it is slotted; it is then carried on to the discharge point and dropped into a pan provided for the purpose.

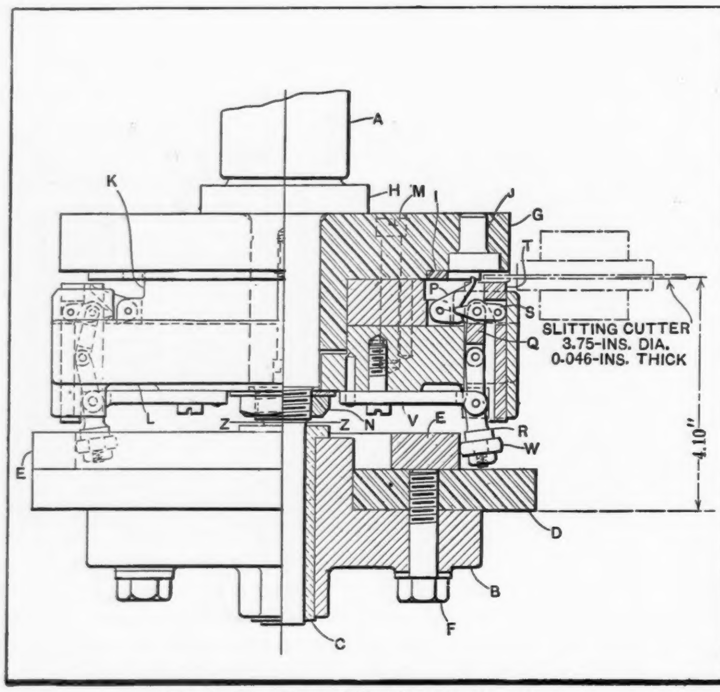

Fig. 1. Plan View of Slotting Attachment

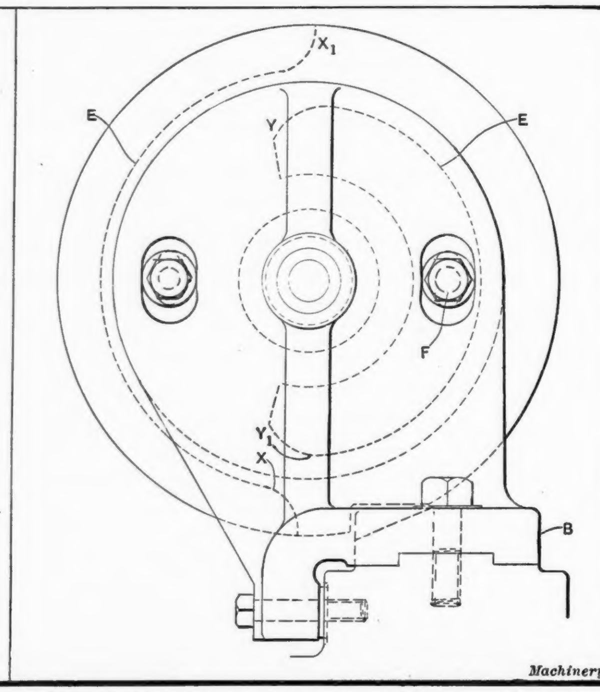

Fig. 2. End View, showing Arrangement of Cams and Bracket

In starting to give a detailed description of this fixture, reference is first made to Fig. 1 where a plan view is shown. Here it will be seen that the fixture is carried on the horizontal driving shaft A. This shaft is supported at its outer end by the bracket B, which is clamped to the table by means of three cap-screws, and equipped with a bronze-bushed bearing C that carries the shaft.

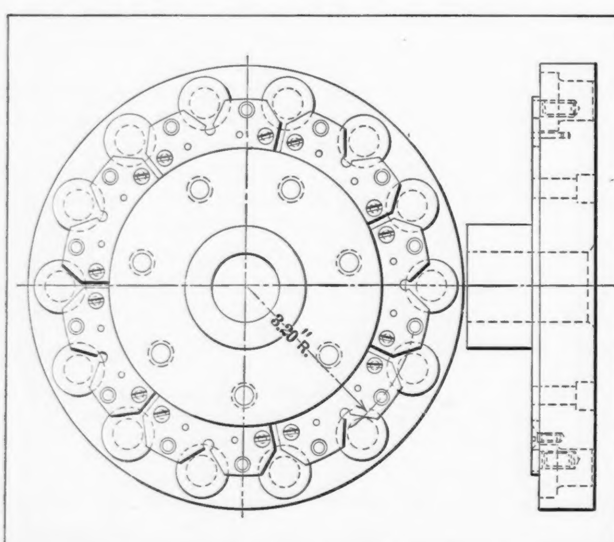

Fig. 3. Casting G, showing Method of Locating Work

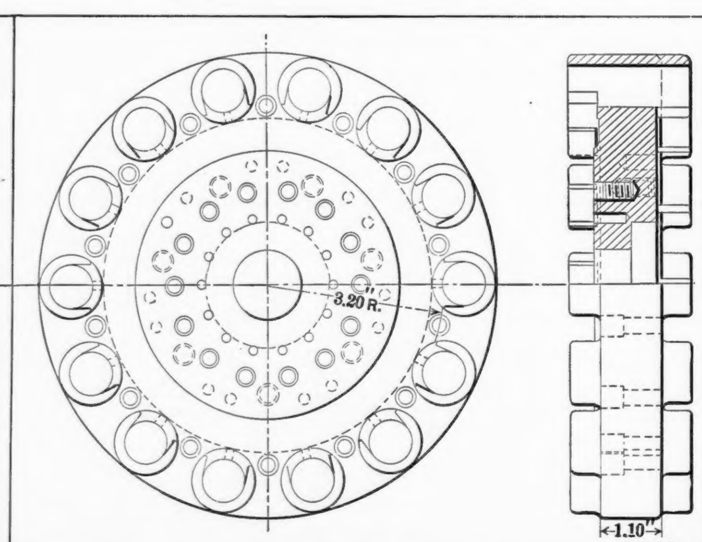

Fig. 4. Casting L, showing Holes for Clamps T

A machine steel plate D is secured to the inner face of the bracket and two cams E are carried by this plate. Two elongated holes are cut in the bracket through which the cap-screws F are passed to secure the plate D to the bracket. These elongated holes give sufficient play to the screws so that the cams may be adjusted to exactly the required position. The arrangement of the bracket plate and cams is clearly shown in Fig. 2. The work is located in V-blocks I, against hardened steel buttons J that are carried by the casting G shown in detail in Fig. 3. This casting bears against the shoulder H on the driving shaft.

The clamping mechanism is carried by two castings K and L, which are doweled together and screwed to the casting G, as shown in Fig. 1. These three castings are secured to the driving shaft by means of the nut and washer N which force them against the shoulder H. The casting K is shown in detail in Fig. 6, where it will be seen that there are fourteen lugs in which the clamping members P are pivoted.

Each clamp is operated by means of a pair of toggle jointed levers R and Q and a link S. As the link S is moved toward the back of the fixture it forces the sharp edge of the clamp P against the work. The opposite end of the link S engages with the clamp member T which slides in a hole in the casting L, as shown in Fig. 4. Each pair of clamping members P and T is thus forced simultaneously against the work by the action of the toggle levers, transmitted through the link S.

To explain the operation of the toggle levers, reference is made to Fig. 1, where one of the fourteen plates V that are screwed and doweled to the casting L is shown. These plates have a bearing at their outer ends in which the members R are pivoted. It will be apparent that any move- of the end of R will open or close the clamping members P

and T on the work through the pivoted connections between these members and S, Q and R. The required movement of the end of the levers R is secured through the action of the rollers W on the cams E. Referring to Fig. 2, it will be seen that the rollers at the ends of R bear against the inner sides of the cam plate at the left of the fixture from X to X_1. This holds the clamps open until the point Y is reached; from this point to Y_1, the roller bears against the outside edge of the cam on the right and between these two points the clamps are closed.

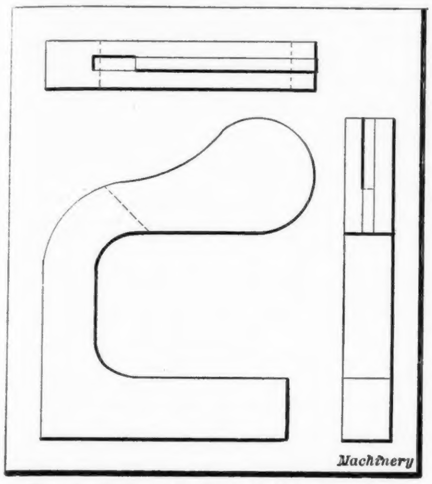

Fig. 5. Typewriter Part slotted as shown

It will be seen from this description that the work is placed in the fixture on the left hand side, where the clamps are open. It is then carried around to the right, where the clamps close before the work is fed to the cutter. The work is still held in the fixture until it has reached the point X. Here each successive clamp opens and drops its work into a pan conveniently placed for the purpose. As the operation of the fixture is continuous, it enables the work to be rapidly handled at a consequently low cost.

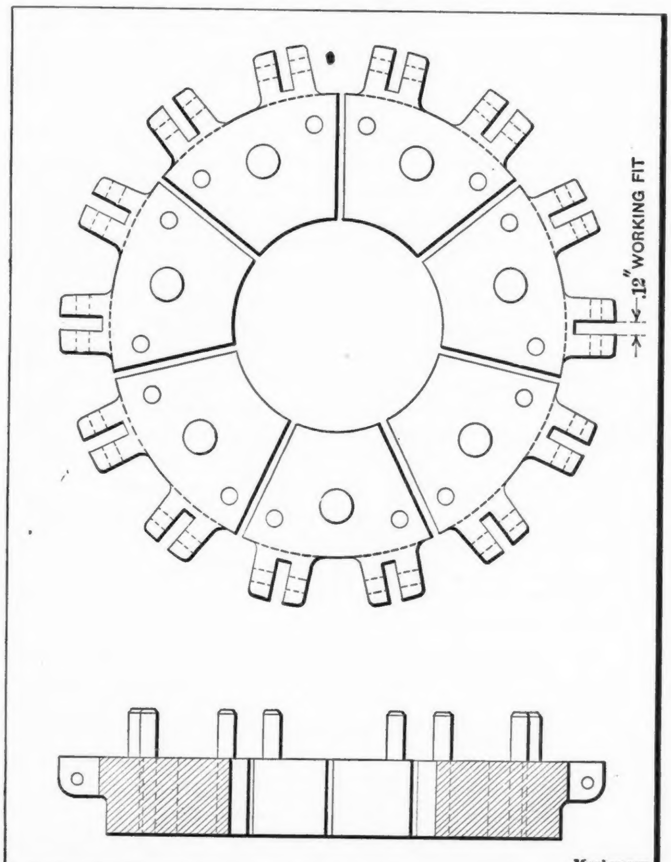

Fig. 6. Casting K, showing Method of pivoting Clamp P

* * *

Some interesting data is given in *Teknisk Tidskrift*, from a German source, of the large hydro-electric development at present being planned at Lyons, France. A dam is to be built across the Rhone which will produce a head of about 225 feet. The average amount of power that can be developed throughout the year is 350,000 horsepower. Present calculations indicate that it will be possible to deliver power from this development at the price of slightly less than one cent per kilowatt hour. It is planned to distribute the power over an area having a radius of between two and three hundred miles.

A PATENT OFFICE PARADOX

BY ROBERT MILLER*

Much has been published recently about proposed changes in the patent laws of this country. Numerous statesmen have drafted bills to remedy the evils that have been apparent for years. All this proposed legislation deals, however, only with the scope of the patent, and not one single sentence attempts to correct the one crying abuse of the entire system—interference.

When an inventor has his first dealings with the patent law he imagines that, except for whatever may be revealed by a search, and patent office citations against his application, he is fairly secure in his possession of protection for that which his brain has conceived. Yet, should an interference be declared, he awakes with a rude shock. It may be proper to first explain the term "interference." An interference is a proceeding instituted for the purpose of determining the question of priority of inventions, between two or more parties claiming substantially the same patentable invention. This sounds simple, but in its amplified form it can readily be made the means of the rankest injustice. For instance, A has a patent which has been issued for some time; if B files an application for the identical invention, an interference may be declared, provided B's application is filed within two years of the date of issue of A's patent. If the subject of the patent is a very valuable one and B happens to represent a powerful corporation, A, being a private individual, may be unable to fight for his rights.

The proceedings in an interference may be very costly, and are as follows: A notice of interference is sent to each party by the examiner of interferences; each party is then required to set forth, under oath, all of the details and circumstances, with dates, regarding the invention. These affidavits must be filed with the examiner before a certain date, and are termed preliminary statements. The examiner then appoints a time when testimony may be taken by each party to establish his position. During these proceedings an applicant or his attorney may cross-examine witnesses.

All this, of course, takes time, and, being legal procedure, also considerable money. Any patent attorney, therefore, would much rather handle a nice, complicated interference, than half a dozen ordinary applications. It might be possible, under the two-year clause, for a powerful interest to have an application filed after the issue of a patent, copying it, line for line and word for word, and by means of false witnesses prove priority, and thus have the original patent nullified and a new patent issued to itself. Further, the patent office itself, by its complicated rules, does not help to simplify the matter.

The writer will now describe an actual case, using some of the phraseology of the patent office. In this case A applied for a patent on a device in March, 1910; except for a few trivial references cited against the application, it was a clear case, and the claims were allowed in May of the same year. Being in no hurry to have his patent issued, he allowed almost the legal six months to elapse before making his final payment of twenty dollars. The patent was issued in December, 1910. The patent received considerable attention in the trade press, as the device was of a type just then of considerable interest to the industry.

In August of the following year A received notice of an interference with B. The usual preliminary statements were filed, and it was learned that B had filed his application in July, 1909, almost a year before A had. The drawings and specifications showed that both were identical in so far as the idea of the device was concerned. The claims were different, yet any novice could see that here were two applications lying together in the same class and sub-class, for a patent of the same device. Yet, the patent office did not declare an interference at this time, but waited until after the issue of the patent to A.

An industry might have been organized on the strength of A's patent, which would have prospered for a short time, and which would then either have been forced out of business, or been obliged to pay B large royalties—all this after having

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obeyed the letter and spirit of the law, acceding to every requirement of the patent office and paying the just dues.

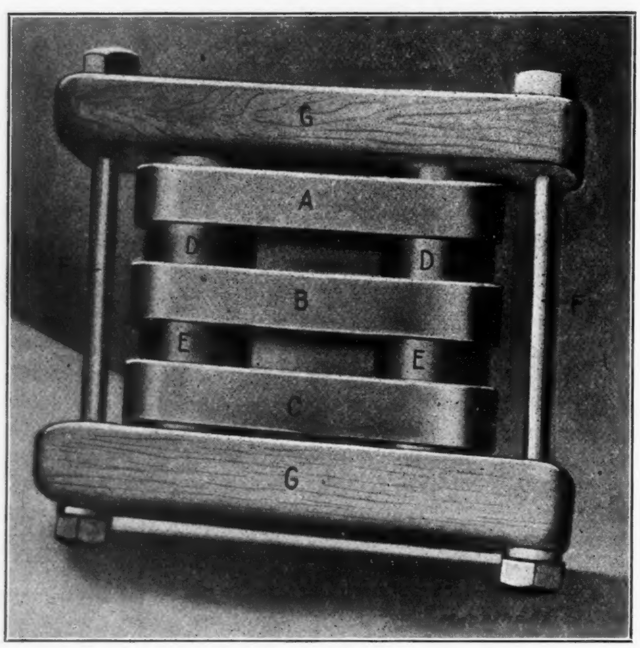
A direct appeal was made to the commissioner to explain this peculiar occurrence, asking why the interference had not been declared before the issue of the patent. The reply was that as the claims were different, "it was not proper to suggest A's claims to B." A case was then cited to the commissioner in which the office had suggested claims to both parties for the purpose of causing an interference. The reply to this communication quoted some obscure rule that was supposed to fit the case. The patent was, of course, granted to B as it should have been in the first place. For this same patent, therefore, two complete fees were paid, and to the man in the street it would seem as if there ought to be a refund. To a lawyer this would seem to be a square deal—with about ten thousand interferences a year the profession should prosper; to the man trying to improve things, it is discouraging.

* * *

A BUILT-UP LIMIT GAGE

At the shops of the New Departure Mfg. Co., Bristol, Conn., a type of limit gage is used by the inspectors that has the advantage of being easily kept in good condition. The illustration represents the general appearance of the gage.

The openings in the gage are the spaces between plates *A* and *B* and *B* and *C*. The space between *A* and *B* is regulated by size blocks *DD;* in this particular instance the size blocks are 0.4999 inch. The opening between *B* and *C* in this gage is regulated by size blocks *EE* which are 0.5001 inch in thickness. The strips *A*, *B*, and *C* may be of any convenient thickness and, of course, they are hardened and



A Built-up Limit Gage

the gaging surfaces are ground and lapped. The important parts of the gage, parts which regulate its accuracy, are the size blocks *EE* and *DD*, which, of course, must first be very carefully ground and lapped to size. After the size blocks have been placed between the gaging strips, small disks are applied to the outside of the strips *A* and *C* and the entire built-up gage is clamped together by bolts *FF* which pass through wooden strips *GG*. The object of the wooden strips is to provide a means for handling, without affecting the accuracy of the gage by the heat of the hand.

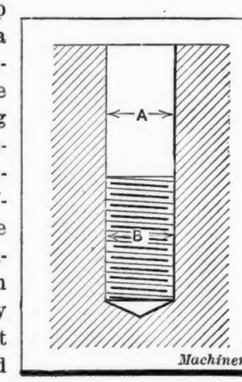
To maintain the accuracy of such gages it is only necessary from time to time to release the tension upon bolts *FF*, remove strips *A*, *B* and *C*, and regrind and relap the four gaging surfaces. It is not necessary to touch the size blocks as no wear comes upon their surfaces. C. L. L.

* * *

When cold-rolled stock is used, an allowance must be made in the bore, as this stock comes exactly to size or a trifle over size. When turned shafts are used, the bore should always be made standard, and the allowance made in the journal.

THE SCREW THREAD STANDARDS

Since a few years ago when the tap makers agreed to start a campaign against the sharp V-thread, the use of this form of thread has steadily diminished. Some of the tap makers, however, state that they still make as much as forty per cent of their taps with V-threads, while others make only from thirty down to ten per cent of their total production with this kind of thread, the remainder being the United States standard. An interesting reason given for the continued use of the V-thread by one of the largest machine tool building firms in the country, is that a V-thread tap permits the tapping of the bottom of a counterbored hole with the same diameter thread as the diameter of the counterbore. In the accompanying illustration the diameter of the counterbore *A* and of the thread *B* is nominally the same. When a sharp V-thread tap is used, of correct angle diameter, it will not be over the standard size on the outside diameter, on account of the small flat necessarily provided on the top of the threads. It can, therefore, enter the counterbored hole and tap the thread without scratching or marking the sides of the counterbored hole, which, in many cases, is required to be a good fit for the stud entering into it. If a U. S. standard thread tap were used, instead, the outside diameter of this tap would ordinarily have to be a certain amount over size, and hence, it would scratch or mar the counterbored portion of the hole when entering. To avoid this, most designers have been in the habit of making the counterbore larger in diameter than that of the threaded portion, but this, of course, necessitates a shoulder on the stud and a larger diameter of stock. It would seem, however, that the condition mentioned would be met with in machine design so seldom, comparatively speaking, that it should not be necessary to maintain two standard screw threads on this account. The committee appointed by the American Society of Mechanical Engineers to investigate into allowances and working limits for the U. S. standard thread, will probably take up this question and suggest some means of overcoming the difficulty even when a U. S. standard thread is used. It is not desirable to have the two thread forms continued side by side, especially since—as has been repeatedly pointed out in these columns—there is no accepted standard dimensions for the sharp V-thread, the different manufacturers making taps with this thread to different standards or gages.



A Condition where the Sharp V-thread has shown Advantages over the U. S. Standard Thread

There may be cases where the U. S. standard thread is not the best one for the purpose, but they are comparatively few. One is staybolt taps which are being more and more generally made with a Whitworth thread on account of the decreased tendency of the staybolts to break when this thread is used. On account of the unequal expansion of the side sheets, the staybolt is bent back and forth, and if there is a sharp corner at the bottom of the thread, as in the case of the U. S. standard or the V-thread, a crack is more liable to develop than when the bottom is rounded, as in the case of the Whitworth thread.

The A. S. M. E. standard for machine screws seems to gain ground rapidly. Some tap makers state that they make nearly all their machine screw taps according to this standard, while others still make from thirty to fifty per cent of the old V-thread standard. There is a tendency among the larger concerns to adopt the A. S. M. E. standard exclusively, while the smaller concerns, to whom the expense for new gages is more serious, still retain the old standards. It would be a great advantage to the tap and screw makers, as well as to the mechanical trade in general, if the old standards could be entirely eliminated. It would seem possible for the tap makers to agree to make the old standard thread only to order, and to charge a higher price for taps with this kind of thread so as to discourage the use of the V-thread on both the machine screw sizes and on larger dimensions of screws and taps.

DESIGNING A HOB FOR HOBBING SPUR GEARS*

DETERMINING THE THREAD SHAPE, NUMBER OF FLUTES, AND GENERAL DIMENSIONS

BY JOHN EDGAR†

A reader of MACHINERY has requested information regarding the design of a hob to cut spur gears. The gears to be cut are cast-iron, and have 120 teeth, 16 diametral pitch and ⅝ inch width of face. The pitch diameter, hence, is 7½ inches. The hole in the hob for the spindle is to be 1¼ inch in diameter with a ¼-square inch keyway, the hob to be run at high speed.

The first thing to be settled is the form and dimensions of the tooth or thread section of the hob. If the form is to be the standard shape for the involute system with a 14½-degree pressure angle, the dimensions of the hob tooth would be as

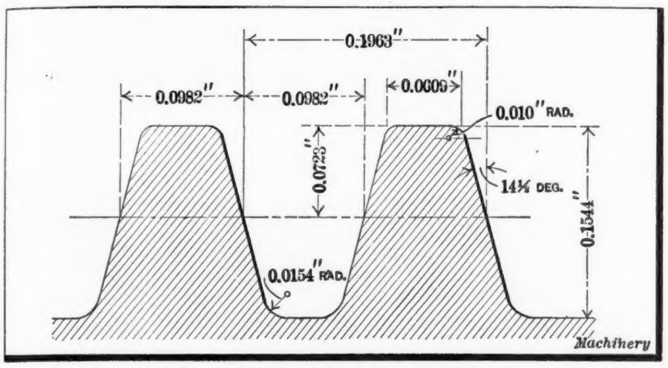


Fig. 1. Standard Hob Tooth Dimensions

shown in Fig. 1. A modification of this shape may in some cases be advisable, and will be referred to later in this article. The standard rack-tooth shape with straight sides, as shown in Fig. 1, however, is the easiest to produce, and unless gears with a very small number of teeth are to be cut, it is entirely satisfactory.

The circular pitch corresponding to 16 diametral pitch is 0.1963 inch which is obtained by dividing 3.1416 by 16. The thickness of the tooth on the pitch line is one-half of the circular pitch, or 0.0982. The height of the tooth above the pitch line is equal to the reciprocal of the diametral pitch plus the clearance, which latter is equal to 0.1 of the thickness at the pitch line. Hence, the height of the tooth above the pitch line equals $0.0625 + 0.0098 = 0.0723$ inch. This distance equals the space in the gear below the pitch line.

The depth of the tooth of the hob below the pitch line is usually made greater than the distance from the pitch line to the top of the tooth. The extra depth should be equal to from one-half to one times the clearance. On small pitches, one times the clearance is not too great an allowance, and, therefore, the depth below the pitch line is made equal to $0.0723 + 0.0098 = 0.0821$, making the whole depth of tooth equal to 0.1544. The extra depth at the root of the thread is to allow for a larger radius at the root, so as to prevent cracking in hardening. The radius may then be made equal to two times the clearance, if desired. In the illustration, however, the radius is made equal to 0.1 of the whole depth of the tooth. The top corner of the tooth is rounded off with a corner tool to a radius about equal to the clearance, or say 0.010 inch. This corner is rounded to avoid unsightly steps in the gear tooth flank near the root. Having obtained the hob tooth dimensions, the principal dimensions of the hob may be worked out with relation to the relief, the diameter of the hole and the size of the keyway.

The proper relief for the tooth is a matter generally decided by experience. We may say that, in general, it should be great enough to give plenty of clearance on the side of the tooth, and on hobs of 14½-degree pressure angle the peripheral relief is, roughly speaking, about four times that on the side. For cutting cast iron with a hob of the pitch in question, a peripheral relief of 0.120 inch will give satisfactory results; for steel, this clearance should be somewhat increased. The amount of relief depends, necessarily, also upon the diameter of the hob.

With a peripheral relief of 0.120 inch, the greatest depth of the tooth space in the hob must be $0.1544 + 0.120 = 0.2744$. The gash will be made with a cutter or tool with a 20-degree included angle, 3/32 inch thick at the point, and so formed as to produce a gash with a half-circular section at the bottom. The depth of the gash should be 1/16 inch deeper than the greatest depth of the tooth space, or about 11/32 inch.

The radius of the hob blank should be equal to $5/8 + 1/8 + 11/32 +$ the thickness of the stock between the keyway and the bottom of the flute. If we use a 3-inch bar we can turn a hob blank 2¾ inches in diameter from this, which would allow sufficient stock to be turned from the outer portion of the bar to remove the decarbonized surface. If we make the blank 2¾ inches in diameter we have 9/32 inch of stock over the keyway, which is sufficient.

The number of gashes or flutes depends on many factors, some of which have been previously discussed in MACHINERY. (See the article "How Many Gashes Should a Hob Have?" in the January, 1909, number.) In Fig. 2 is shown an end view of a hob with twelve gashes. This number gives plenty of cutting teeth to form a smooth tooth surface on the gear without showing prominent tooth marks. A larger number of gashes will not, in practice, give a better tooth form, but simply increases the liability to inaccuracies due to the forming process and to distortion in hardening. This number of gashes also leaves plenty of stock in the teeth, thus insuring a long life to the hob.

The question whether the gashes should be parallel with the axis or normal to the thread helix is one that is not easily answered. It must be admitted that when the angle of the thread is great, the cutting action at both sides of the tooth is not equal in a hob with a straight gash; but in cases

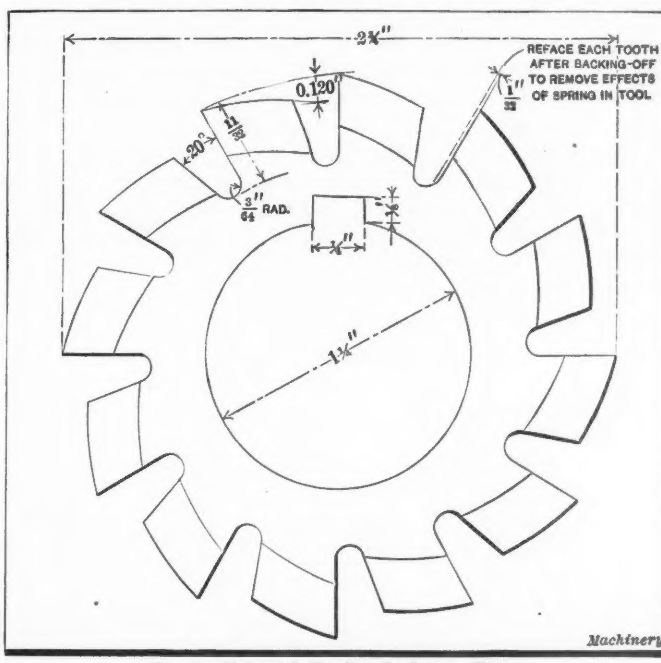


Fig. 2. Hob with Twelve Gashes or Flutes

of hobs for fine pitch gears, where the hobs are of comparatively large diameter, thus producing a small thread-angle, the parallel gash is more practical because it is much easier to sharpen the hobs, and the long lead necessary for spiral gashes, in such cases, is not easily obtained with the regular milling machine equipment. However, when it is desired to obtain the very best results from hobbing, especially in cutting steel, the gash should be spiral in all cases when the thread angle is over 2½ or 3 degrees. In our case the thread angle figured at the pitch diameter of the blank is equal to 1 degree 22 minutes; hence, straight flutes are not objectionable.

* See also MACHINERY, July, 1912, "Hobs for Spur and Spiral Gears," and the articles there referred to.

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The linear pitch of the hob and the circular pitch of the gear, when considered in action, are to each other as 1 is to the cosine of the thread angle. In the present case they do not differ appreciably and may be considered as equal. In cases where the difference is over 0.0005, the true linear pitch should be used.

The change-gears for the lathe may be figured by the formula:

$$\frac{\text{Gear on lead-screw}}{\text{Gear on stud}} = \frac{\text{lead of lead-screw}}{\text{linear pitch of hob}}$$

On a lathe with a lead-screw of six threads per inch, or a lead of 1/6 or 0.1667 inch, the gears that would give accurate enough results for the present hob would be 28 teeth on the lead-screw, and 33 teeth on the stud.

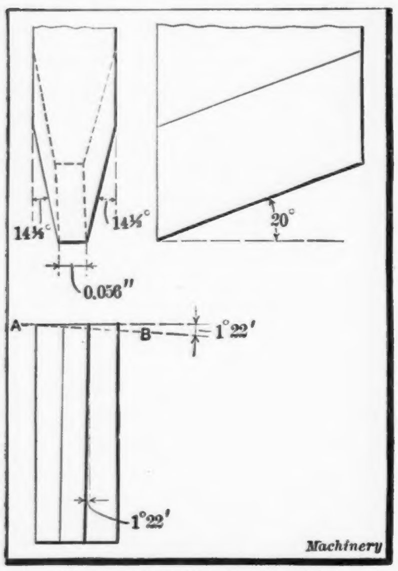


Fig. 3. Threading Tool for Hob

In Fig. 3 is shown the hob thread relieving tool. The front of the tool is relieved with a 20-degree rake for clearance. The sides are ground straight at a 14½-degree angle to form the sides of the thread, and are at an angle of 1 degree 22 minutes with the vertical to clear the sides of the thread. A tool made like this can be sharpened by grinding across the top without losing its size or form. If the gashes were made on the spiral, the top of the tool should be ground to the angle of the thread, as shown by the dotted line *AB*. In cases where the angle of the thread is considerable, the angle of the sides of the tool must be corrected to give the proper shape to the hob tooth. (See MACHINERY, May, 1905, or MACHINERY'S Reference Book No. 32, "Formula for Planing Thread Tools.") The point of the tool should be stoned to give the proper radius to the fillet in the bottom of the hob tooth space.

The best practice in making the hob is to anneal it after it has been bored, turned, gashed and threaded, the annealing taking place before relieving the teeth. Before hardening, the hob ought to be re-gashed or milled in the groove, removing about 1/32 inch of stock from the front side of the tooth to eliminate chatter marks and the effect due to the spring in

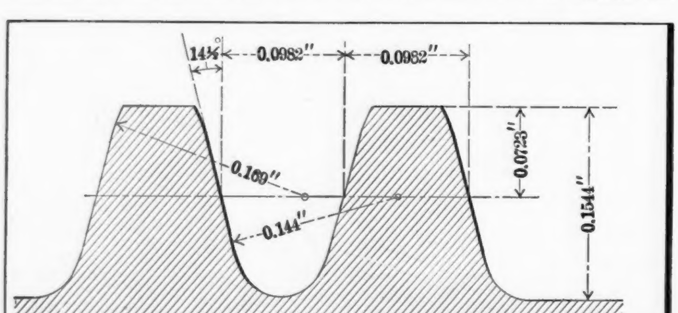


Fig. 4. Special Hob Tooth Dimensions

the tool, which always leaves the front edge of the teeth without relief. In hardening, do not attempt to get the hob too hard, as the required high heat and quick cooling would distort the teeth badly.

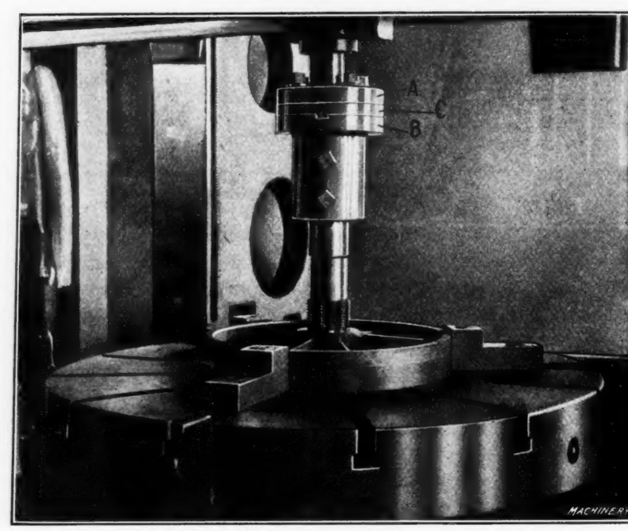
In case the 120-tooth gear is to run with a pinion of a small number of teeth and is the driver, as in small hand grinders where gears of this size are often used, it would be advisable to make the tooth shape as shown in Fig. 4. This shape will obviate undercutting in the pinion and relieve the points of the teeth in the gear so as to obtain a free-running combination. This shape is more difficult to produce and requires more care in forming. If the hob is made of high-speed steel, it should run at about 115 revolutions per minute for cutting an ordinary grade of cast iron with a feed of 1/16 inch per revolution of the blank. The feed may be increased considerably if the gear blank is well supported at the rim. The best combination of speeds and feeds in each case can be found only after considerable experimenting.

* * *

METHOD OF TAPPING FACEPLATES ACCURATELY IN A BORING MILL

At the New Haven Mfg. Co., New Haven, Conn., an interesting application of the familiar "Oldham" coupling is made use of in tapping the spindle holes of faceplates. Formerly considerable trouble was experienced when tapping faceplates, because if the work was not located exactly true with the boring machine spindle the tap would invariably cut large. By using the coupling shown in the illustration, trouble from this source has been overcome.

The upper half *A* of the coupling is held in the boring machine spindle and the lower half *B* supports the tap. Both these parts have on their inner faces shallow rectangular slots approximately ¼ inch deep by 1½ inch wide. The central part *C* of the coupling has on its upper face a tongue to



Tapping Faceplates in a Boring Mill

fit the slot in the upper half and on its lower face a tongue is provided at right angles with the one on the upper face fitting in the slot in the lower half of the coupling. Four large cap-screws are provided which are threaded into the lower half of the coupling but pass through enlarged holes in the central and upper halves of the coupling. These screws serve merely to hold the parts together and do not prevent the parts of the coupling from adjusting themselves while the tapping operation is being performed. With this fixture the tap quickly finds a central location in the faceplate and the result is that the holes are quickly and accurately tapped.

C. L. L.

* * *

A Bureau of Mines paper states that all commercial explosives owe their power of doing work to the expansive force of the great volume of gas evolved from them at the moment of explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases: 40 per cent dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given above.

MOLDING DIES FOR FIBER INSULATION

BY EVERETT CHIPMAN*

The black fiber insulations shown in Fig. 1 are formed in molding dies which it is the purpose of this article to describe. The stock consists of fiber tubes which are made by rolling material of the thickness of paper on iron bars. During the rolling process, heat is applied in such a way that the material, which consists of pulp from wood fiber, is joined together to form a solid tube. The tubes are received in lengths of about 3 feet, and of varying diameters; they are sawed up into blanks of the right size for the different insulations and are then transferred to the forming presses.

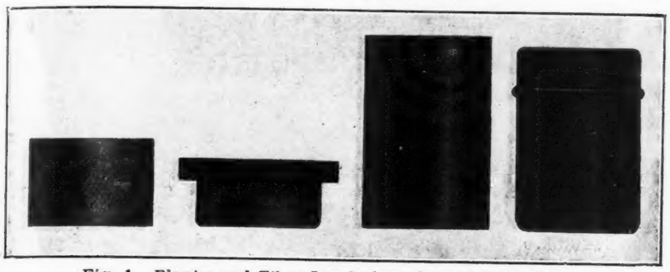
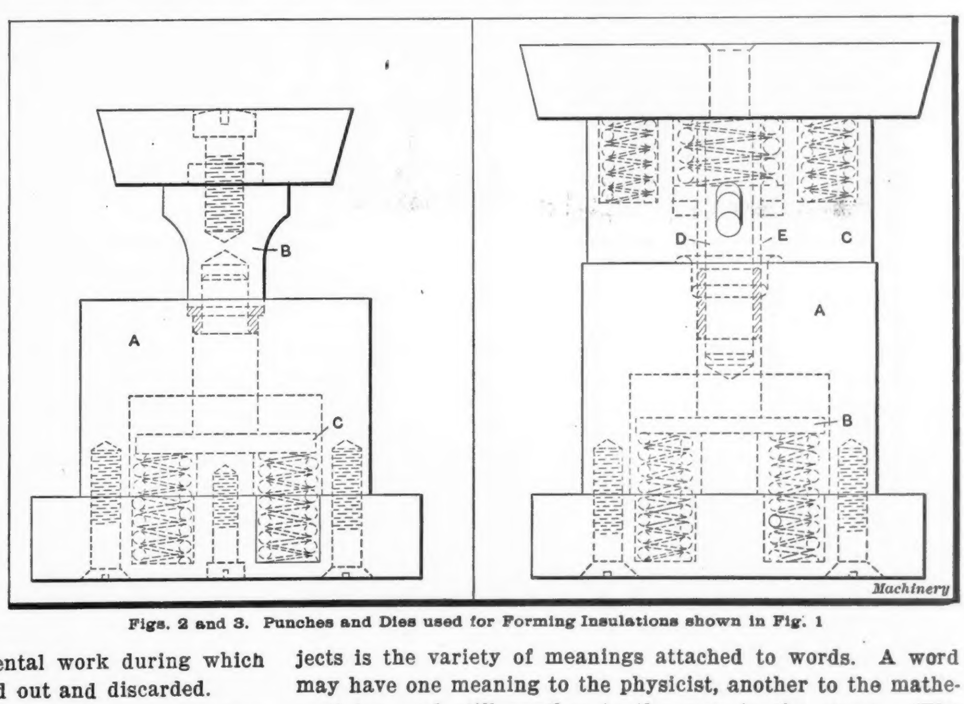


Fig. 1. Blanks and Fiber Insulations formed from them

Fig. 2 shows the punch and die used for molding the insulation shown at the left-hand side in Fig. 1. In this operation the shoulder is formed at the top and the lower edge is rounded at the same time. During this forming process the pressure applied causes a certain amount of shortening to take place; consequently it is necessary to allow enough extra on the length of the blanks to make up for this compression. The blanks are fed into the die by hand.

Reference to Fig. 2 will make the design of the punch and die used for this operation readily understood. *A* is the mold or form in which the outside of the blank is shaped. *B* is the plunger which is fastened to the head block of the press. *C* is the stripper for the form *A*; *C* also acts as a locating plug and forms the radius on the lower end of the blank. The plunger *B* has a recess into which the central stud of *C* enters as the press descends. The work is then formed in the space left between the mold *A*, the punch *B* and the locating plug *C* on the stripper, after the stripper has been pressed down to its lowest position. When the forming operation is completed, the finished blank is ejected by the action of the springs under the stripper. The finished insulation is held on the central plug of the stripper when the plunger has reached the top of its stroke, and can be readily removed with a fork-shaped piece of metal which lifts it off by means of the shoulder. This mold is used in a press having a ½-inch stroke and the work is produced with a variance of only two or three thousandths of an inch.

Fig. 3 shows a rather more complicated punch and die which is used for forming the insulation shown at the right-hand side in Fig. 1. This die represents the result of about three months experimental work during which time a number of methods were tried out and discarded.



Figs. 2 and 3. Punches and Dies used for Forming Insulations shown in Fig. 1

In forming this insulation both the upper and lower edges are rounded and a shoulder is formed on the side as shown. It was the method of forming this shoulder which constituted the difficult point in designing the punch and die. The following notation has been adopted in Fig. 3 for refering to the different parts of the punch and die. *A* is the mold; *B*, the stripper for the mold; *C*, the punch; *D*, the stripper for the punch; and *E*, the central or locating plug. It will be noted that in this case the locating plug is carried by the punch stripper instead of by the mold stripper as in the preceding case.

The blanks formed in this mold fit into the recess in the die and rest on top of the stripper. The die is bored out to the outside size of the shoulder for a depth of about ⅜ of an inch, and there is an annular ring on the punch which comes down and fills the space between the outer wall of the blank and the outer diameter of the recess in the die. The lower edge of this ring is rounded and with the base of the counterbore in the die forms a semi-circular cavity in which the shoulder is formed. As the punch descends the central pin locates the blank and then enters the recess in the mold stripper which has been provided to receive it. The blank holds the two strippers apart against the tension of the springs until each stripper has reached its stop. The pressure is then increased, and since the only relief is in the ring at the point where the shoulder is formed, the fiber gives at this point and conforms to the desired shape. The punch and die stripper are of such a form that they round the corners at the top and bottom of the insulation as shown. During the return stroke of the press the strippers force the bushing to leave both the punch and die, and the finished work is left on the lower end of the locating pin, from which it can be readily removed.

During both of these forming operations there seems to be a slight movement between the layers of material in the blanks. The finished work, however, is perfectly compact, and if such a movement does take place it is probable that the heavy pressure of the forming operation generates sufficient heat to reunite the layers before the operation is completed. In each case the use of these dies has meant a great saving over the former method, which was the use of a molded paste composition for the smaller and screw machine work for the larger piece. The press method also produces more accurate work with less breakage.

* * *

WHAT IS SPACE?

In a paper on the fourth dimension, published in the *Polytechnic Engineer* for 1912, William J. Berry states that a serious difficulty presented in discussing mathematical subjects is the variety of meanings attached to words. A word may have one meaning to the physicist, another to the mathematician, and still another to the man in the street. "The average layman thinks of space, if indeed he thinks of it at all, as a huge box or hollow sphere in which all things lie—a sort of frame for the material universe. This idea is crude and vague. . . . . . Space is an idea caused by the perception of simultaneous groups of phenomena. Space is not a phenomenon or a group of phenomena, though without phenomena there can be no idea of space." The idea of space is subjective, and is distinguished in three forms, *i. e.*, visual space, tactual or feeling space and motor or traveled space.

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ACTION OF PEENING STRAINS IN A CAST-IRON BENCH PLATE

BY DOUGLAS T. HAMILTON*

A cast-iron bench plate was recently brought to the Cleveland Machine Tool Co., Cleveland, Ohio, for machining, which was sprung out of shape, being 3/16 inch high in the center lengthwise and 1/8 inch high crosswise. This bench plate, which is shown in Figs. 1 and 2, is 7 feet long by 3 feet wide, the plate portion being 1½ inch thick before machining.

To straighten this plate, it was carefully clamped to the planer table, and a 3/16-inch cut taken over its entire surface. After taking this cut, a straightedge was placed on the plate which to the astonishment of the operator was found to be 3/16 inch low in the center. The supports under the center portion of the plate were held so tightly that they could not be moved, while the supports under the ends were loose. Another 3/16-inch cut was then taken and when the straightedge was applied, the plate was found to be 1/32 inch high in the center. A 1/32 inch cut was then taken, the straps released a slight amount and a final cut about 1/64 inch removed, which brought the surface of the plate back to a true plane.

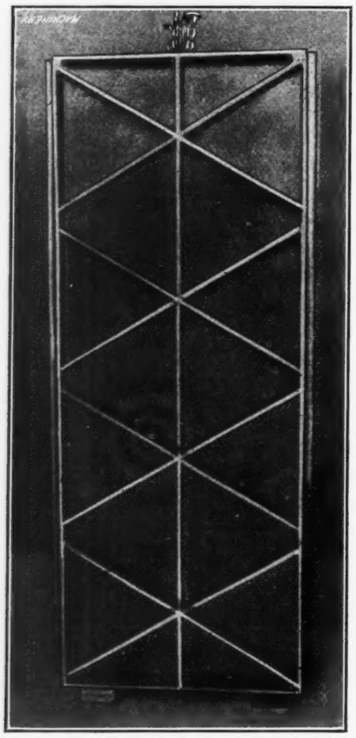

Fig. 1. View of Bench-plate showing Triangular Ribbing

Fig. 2. Condition of the Plate after Machining

In clamping, particular care had been taken not to spring the plate, so that the action just mentioned cannot be due to that cause, and as is evident in the illustration Fig. 1, the plate was well ribbed and supported. The only conclusion which can be drawn from this peculiar action of springing, is that the plate had been used more in the center than at the ends, and that the surface had become stretched and hardened due to the continued peening action caused by hammering and placing work on it. Then when this hard scale was removed, the plate returned to its normal state—the fibers straightening out—this action being similar to that which takes place in a rod of cold-rolled steel, when only a portion of it is machined.

It is reasonable to assume that this same condition exists to a slight extent in a planer table which has been subjected to considerable use and abuse. The action of this plate also shows that extreme care is necessary in handling work on a planer table; it should not be used either as an anvil or a straightening plate, but simply as a means for holding the work while machining. Another point brought out by the action of this plate is that one cut cannot be relied upon to straighten a surface when it has become sprung. Some mechanics, when they get a job to do on the planer which must be accurate, put a broad tool in the holder and take a skin cut from the platen, thinking that by so doing they are producing a true plane. The fact of the matter is that in nine cases out of ten they have only partially relieved the strain and inaccuracy, especially if the planer has been in use for some time and has received rough usage. After taking a cut, the truth of the table should be proved with a dial test indicator held in the tool-holder, and it is generally advisable to take two cuts instead of one, that is, if the table is not sprung much, the dial test indicator being used to ascertain when the table has been brought back to a true plane.

* Associate Editor of MACHINERY.

* * *

THE INSPECTOR

BY JOHN F. WINCHESTER*

Writers in mechanical magazines often dwell on the importance of inspection systems and their relation to modern shop practice, but they seldom mention the qualifications necessary for a man to suitably fill the position of inspector, or the training that a man receives by occupying one of them. When it is considered that the keystone of success in many of our large manufacturing establishments is the inspection system, it can be seen that the human element should receive no small amount of consideration.

The requirements necessary for a man to fill satisfactorily the position of inspector vary with the concern for which he works and with the work to be done. In some factories there are inspectors who do nothing but measure duplicate parts; this particular branch of inspection can be filled by specialists with little training. In these same factories, however, there are inspectors who pass upon the final product. These men are held strictly responsible for the satisfactory operation of the product, and fill highly responsible positions.

Since the advent of the automobile, there has been a demand for another class of inspectors who are to pass upon all material that is to be used in the process of manufacture. These men test the material from the steel and iron mills and foundries, to ascertain if it meets with the required specifications. They are chemists or metallurgists, and generally have a college education or special training in that particular branch. This field is not closed to the shop-trained man, however, for with the correspondence schools, and with special courses in the engineering schools that now abound, it is within reach of him.

A man who had been promoted to an inspector was asked how he liked his new duties. He answered, "At its best, it is a thankless faultfinding position." This man did not possess the tact or proper ability to successfully fill his position and was mistaken in his estimate of it. It is not faultfinding when an inspector endeavors to detect the possible mistakes of others and report them to his superior, in order to prevent inferior goods from being produced.

The concern which employs the grades of inspector before mentioned usually has a chief inspector whose duty it is to oversee the inspection system and decide all important matters relating to it. This man must possess good mechanical training, have a decided, but not too aggressive, manner of passing on questions, and have an absolute knowledge of the details of the work being inspected.

The advantages of holding a position of inspector are numerous. He has a chance to learn by the mistakes of others, and meets with many perplexing problems, the solving of which gives him good training. He also enjoys the association of those higher up; associations count in any line of work, and the inspector, through being in contact with the executive heads of the establishment, is always in line for future promotion. Have we not here one of the ideal positions in a machine shop? I say "one of," for with the difference of opinion that always exists as to an ideal, I dare not put it stronger. It is one to which the apprentice with his boyish ambition may attain, and one which the elderly man who has held positions of greater responsibility, but with whom fortune has not dealt kindly, can accept and yet retain the dignity that he has acquired through his years of service.

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EXPORT TRADE*

SOME OF THE CONDITIONS AFFECTING THE FOREIGN MACHINE TOOL BUSINESS

In no line of exports has the American spirit of ingenuity and invention proved itself greater than in the machine tool line. It is a field in which our conditions of labor made it especially necessary to invent machines to take the place of hand workmen. Following the Civil War there was a particular growth in machine design, and in 1876 the Centennial Exhibition at Philadelphia showed something of this new line of work. Up to this time a few of the manufacturers had been exporting in a quiet kind of way, had done a good deal of business, and had earned for American tools a reputation that was a desirable one. Greater developments in design came about, until seventeen years later at Chicago we had a magnificent showing of machinery that was instructive to ourselves as well as to the foreigners who came in great numbers. The best of the engineering ability not only visited the exhibition, but visited our shops and were received with open arms. Progress had been made in foreign countries, but not to the extent that was shown in America, and after the exhibition we had a very voluminous trade. Be it said to the honor of the machine tool builders that most of the material that went abroad was material that stood upon its merits and added to the reputation that our tools had already attained abroad. There were, unfortunately, some cases where unprincipled advantage was taken of the opportunity, but the great majority of the manufacturers seemed to appreciate the real value of the opportunity.

Since that time our foreign friends have no more stood still than have we, and in the reports obtained from those who visit the foreign market to study conditions we get confirmation of what we see with our own eyes when visiting these countries—that designs are constantly improving, and that the workmanship is approaching that which we furnish from this side. That we are copied to a greater or less extent may be sincere flattery, and while we can accept as a fact that a copy can be but second best, it is dangerous from a commercial standpoint for the reason that many are persuaded that it is as good; and the lower price that can be quoted by reason of the elimination of designing and experimental costs, to say nothing of difference in wages, adds to the difficulties in competition.

Neither our own nor any other country can or should have all of the business in machine tools. As our lines develop, there is no question but that one foreign country may excel another and ourselves in a given line of development, and when such a fact is realized, we should be as open-minded and as ready to purchase as we are to desire others to consider and purchase from us.

As a people we sometimes pride ourselves on our business spirit. So much have we talked about it that some of our foreign competitors have become so imbued with the fact that they call us not only aggressive, but egotistical, tricky and even brutal in competition. We admit we try to be aggressive, denying the remaining allegations as being too strong, but when we study the methods of some of our foreign competitors in working for export trade, we wonder if we are aggressive even, and our wonder increases as we compare foreign exports with our own. Are we inspired with the possibilities before us, and willing to add perspiration to inspiration?

Export business is no different from any other business in its principles. In our domestic trade there is no lathe nor milling machine tool builder who does not take such steps to sell his goods as will cause them to be purchased rather than the goods of a competing lathe or milling machine manufacturer. In such a case the manufacturer studies the market, and does what he considers is necessary to interest the prospective customer. In export business, instead of dealing with a neighbor who lives within a comparatively short distance of us, speaking the same language and living in the same general atmosphere of business and social conditions, we are dealing with customers who, except in the case of the English, speak another language, and all of whom live under conditions of life and are inheritors of business principles and methods that differ from ours.

What do we do to get domestic business? We try to get designs that are satisfactory and for which there is or can be secured a demand. We try to offer workmanship that is of a high order, and if we have competitors who have equally good designs and present equally good workmanship, we sometimes feel that by manufacturing more cheaply we can sell more cheaply, and thus obtain a market.

To sell goods abroad there are different courses open. The sales can be effected through agents who will act as representatives, through direct travelers, or through general agents who are but little more than commission merchants. There are representatives and representatives. If you sell through a representative that is thoroughly in sympathy with you, who will work for your interests, and who will represent you alone in your line, you are in a position to reciprocate and work for him. Such a representative must be taken into your confidence; you must listen to his requirements, and while it is by no means possible to grant all of the requests that he might make, it is possible to obtain from him suggestions that will help you in obtaining a share of the business that you are seeking. When selling through such a representative you are dealing with a concern that knows the people with whom it deals, knows their peculiarities, and can more readily make a trade than could a direct representative.

To think of sending a direct representative who cannot speak the language is so far from anything that any of us would do that it is hardly necessary to discuss this feature of the question; but given one who understands the language, he has to meet, as a direct representative, conditions that it is not easy for the home people to understand, so that it almost precludes this form of representation. When, however, you second the efforts of your representing agents with the services of a direct representative, results are oftentimes obtained that show that such services are an imperative necessity. This element is one that cannot call forth positive rules. If your machine is a type of special machinery, the need is far greater than when it is a type of standard machinery, and where to draw the line is a matter of opinion.

When goods are sold abroad through representatives, it is imperative that the house selling should have first-hand knowledge of conditions existing in their foreign trade. Your agents will write until they are black in the face, and get no response from you, when—did you but know a little of what they are contending with—one letter would have sufficed to place matters in order.

We all have something of an idea of what it means to have our literature in the language of the people that are to use the goods. Yet while we spend large amounts of money on our domestic business—on circulars and all kinds of printed material—we are apt to hesitate at printing in a foreign language when we are looking for the export business. This also brings up the matter of correspondence. Are we as apt to be as prompt in answering our foreign correspondents as we are our domestic friends, especially if the latter are not more than a hundred or two hundred miles away? Are we not a little apt to think, "Well, he has been waiting for ten days, a day or two more will make no difference," rather than to think, "He has been waiting for ten days, and how tedious it must be to have to wait another ten days; therefore this letter will be answered ahead of our New York letter." As a general rule do we watch the sailings of the mail ships as closely as the foreigner and attempt to make certain that given letters and documents reach New York in time to make the best connections?

Have not some of us felt the export business was a splendid thing in bad times, but a nuisance in good times? Have we not been rather apt to give, not a *just* delivery to our foreign friend, but to give him the delivery that was left over after our domestic friends were taken care of? When we are called upon

* Abstract of paper read by Mr. W. A. Viall of the Brown & Sharpe Mfg. Co., Providence, R. I., before the National Machine Tool Builders' Association Convention in New York City, October 16, 1912.

to put up some special form of packing to meet certain conditions, do we not feel that our representative is perhaps a little over particular, if not cranky, and make him feel that what is good enough for us is good enough for him, rather than to attempt to judiciously follow his wishes? Do we visit our representatives or have them visit us so often that we can talk over the things that are going on and become more closely allied? If we do, we are backing up our representative as thoroughly as we are backing our own salesman on our own ground, but if we do not we are merely playing with our foreign business.

The United States is not the only country that has customs' regulations. We find that foreigners take the utmost pains to conform to our American customs' requirements when exporting goods to this country; but when we export to their country, are we not rather apt to consider it more or less of a nuisance to carry out in detail the requirements of those countries, and work half-heartedly, with the result that the receiver of our goods abroad is put to such trouble that he will prefer to buy from the foreigner who meets him, rather than from the American who holds off?

In the case of the foreigner we find that he goes into neutral territory, and we are informed that he will give precedent to the foreign over the domestic business. While this may be hard on his domestic customer, yet there is a national feeling at times that makes him think that he can handle his home trade rather differently from his foreign trade, to the advantage of his home trade, on the theory that he is building up his nation. Our country has not been noted, in the machine tool business at least, as being willing to use foreign countries as dumping grounds of our manufactures in the way of prices, charging all of the overhead expense to the domestic trade, and figuring the prices of the export at flat labor cost without overhead charge, but this is a thing that we are meeting in competition with foreign countries.

Wages are an important element in cost, but they are not standing still abroad. There are those who want to see lower tariffs, which will mean lower cost of living and lower wages, and then perhaps there will be a competition that will be carried forward on a basis we have not yet been able to attain, and many of us hope we shall not attain.

We have one difficulty in getting into European markets that our European competitors do not have, in that we have a great distance to travel, and this oftentimes prevents our sending men, and lessens the number of visitors—conditions which do not prevail among European manufacturers. When the South American and the Far Eastern markets are considered, however, the Europeans have as far to go as we have.

Many of us are of English descent and have inherited some of the English traits. The matter of language is one of them. How often we hear the American saying that the English language is good enough for him and let the other fellow learn English. When we go abroad, however, we find everywhere people that are speaking English. Most of us are acquainted with the young men who come to America for the main purpose of learning English (and, incidentally, to learn some of our methods), and then in turn become the men who are doing business. A knowledge of foreign languages is not an absolute necessity for the export business, but it is certainly one of the advantages that those who possess it have. We would do well to consider whether it would not pay to send more of our young men over, if for nothing more than to acquire one or two of the languages of countries where we want to do business.

If we follow closely the publications of other countries, we find in some of them indications of a spirit of cooperation not always evident in our own country. One of the purposes of our association is to draw together manufacturers so that we can act as a whole, so that we can go forth as a body of American manufacturers rather than as individuals—and results have already appeared in this direction.

In the year 1911 the United States exported to Italy, in metal- and wood-working machinery, 1,000,000 kilograms, and to Germany 6,000,000 kilograms; in 1910 America exported machinery into Switzerland to the value of 500,000 francs and into Germany to the value of 4,000,000 francs; and in 1909 America exported into France machinery to the value of 45,000,000 francs and into Germany to the value of 110,000,000. Considering these figures, is it not time that we carried into effect as individuals, and, when necessary, as an association, that attention to the requirements and desires of the foreign customer that we are giving to our domestic customer every day? In view of the figures quoted, it goes without saying that we must constantly maintain the highest standard of design and workmanship. But beyond this, what is the matter with our American export trade? Are our goods not fitted to the foreign market, or are they not properly presented to the buyer, or are the prices too high?

* * *

MAKING HINDLEY WORM-GEARING AT THE BROOKLYN NAVY YARD

When a battleship is in action it is sometimes necessary to revolve the gun turrets very quickly in order to train the guns or locate them in the proper radial position. Owing to the weight of the guns and their inertia, the mechanism for revolving the turret must be very strong and powerful to withstand the sudden shocks incident to the rapid movements which are occasionally required. The turret rotating mechanism that is applied to battleships now being built in this country consists of two motors connected to a differential gearing from which power is transmitted to the turret through Hindley worm-gearing and a pinion engaging an annular rack attached to the turret base. When both motors are operating at what might be called the normal speed, the differential gearing and turret remain stationary, but by varying the speed of either motor the turret is caused to revolve, the direction of rotation being controlled by running one motor or the other faster than the normal speed. The Hindley worm-gearing is an important part of the turret controlling mechanism, at least from the shop man's viewpoint, because gearing of this type is rather difficult to make accurately, especially in the large sizes required for the purpose mentioned.

The accompanying illustrations, Figs. 1 and 2, show a simple method of producing these large gears, which is employed at the Brooklyn Navy Yard. An ordinary lathe equipped with a special attachment is used for machining both the worm and worm-wheel. Fig. 1 shows how the worm is threaded, and Fig. 2 illustrates the method of hobbing the worm-wheel teeth. The worm is made of steel and has a pitch diameter of 10 inches, whereas the wheel is made of phosphor-bronze, has a pitch diameter of nearly 36 inches, and a circular pitch of 3⅛ inches.

The worm blank, which is integral with its shaft, is first turned to the proper curvature in another lathe, as will be described later. When the worm is being threaded, the right-hand end of its shaft is supported by the tailstock center, and the left-hand end enters a special driving plate *G* (Fig. 1), which is bolted to the regular faceplate of the lathe. A shaft is keyed to this driver and carries a bevel gear *A*. This bevel gear meshes with a corresponding gear *B* attached to a shaft at right angles, which, through the spur gears *C* and *D* and worm-gearing contained in the special base *E*, transmits motion to the spindle *F*. In this way, the worm is caused to rotate in unison with spindle *F* and the tool-holding fixture *H* mounted on it.

The worm thread is formed by two separate operations and two sets of tools are used. The first set are roughing or stocking cutters, which simply form rough grooves, and these are followed by a set of finishing tools which give the threads the required shape. Fig. 1 shows the finishing cutters in the tool-holder and the roughing cutters are on the lathe bed at *J*. The cutting ends of the roughing tools vary in shape, some being square, whereas others are beveled more or less; in addition, there are right- and left-hand side tools on each side of the fixture. By having tools of different shape, some cut in one part of the groove and some in another, which facilitates the roughing operation. There are eighteen cutters in all, the number being equal to one-

half the number of teeth in the worm-wheel. The circular tool-holder is mounted on a cross-slide which is fed inward by handwheel K, the latter being connected with the cross-feed screw through worm-gearing, as shown.

After the thread grooves have been roughed out, the roughing cutters are replaced by eighteen finishing cutters. The tool-holder is so constructed that these tools can be accurately located each time they are placed in position. This holder consists of a circular casting H, having a raised inner ring fitted with set-screws against which the ends of the tools abut, and a circular ring for clamping the tools. The latter are located circumferentially by slots cut in the tool-holder, and radially by measuring the distance between the cutting ends and angle-plate L. In case radial adjustment is necessary, this is effected by the set-screws referred to. The tools are all numbered and there are corresponding numbers on the holder, so that each tool can always be located in the same position. The tops of the tools are, of course, in the same horizontal plane as the axis of the worm. When finishing, the tool-slide must be fed in very slowly, as each tool machines a large surface, thus making it necessary to take light cuts. The gears C and D are so proportioned that each tool, at the pitch circle, moves a distance equal to the circular pitch of the gearing, while the worm makes one revolution. Lubricant for the cutters is supplied by the tank seen above the worm. The collars on each side of the worm are integral with the shaft and engage thrust bearings when the worm-gearing is assembled.

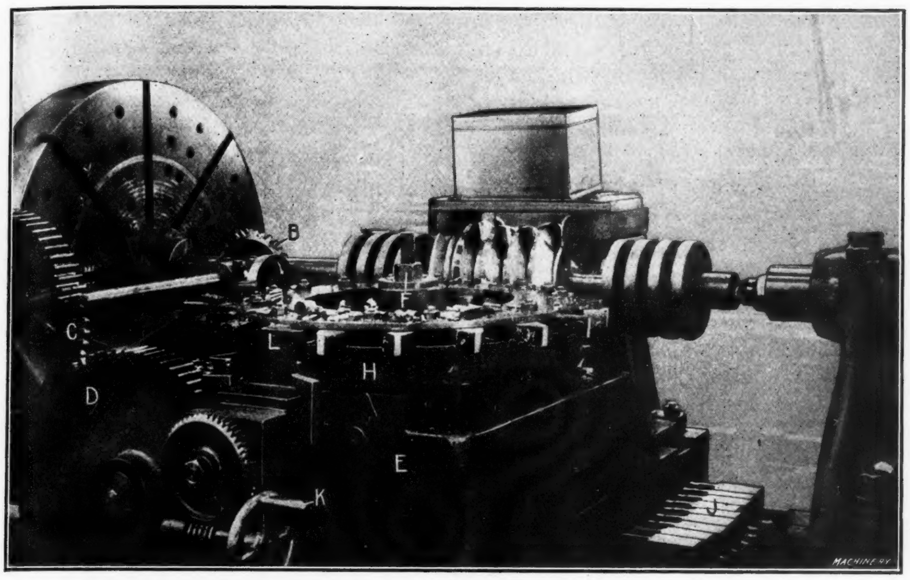


Fig. 1. Generating Thread of a Large Hindley Worm for the Battleship New York

When the worm-wheel is being hobbed (see Fig. 2), it is mounted on the same vertical spindle that drives the tool-holder, the latter being removed. The hob used for this operation has a long shaft which engages driving plate G, to which it is locked by a special key. The hob shaft also carries a bevel gear A for transmitting motion to spindle F through the shafting and gearing referred to. When hobbing the wheel it is necessary to run slowly and take light cuts, the same as when generating the worm thread, in order to secure smooth accurately finished teeth. The time required for hobbing one of these wheels is about five days, whereas the worm is threaded in about six days.

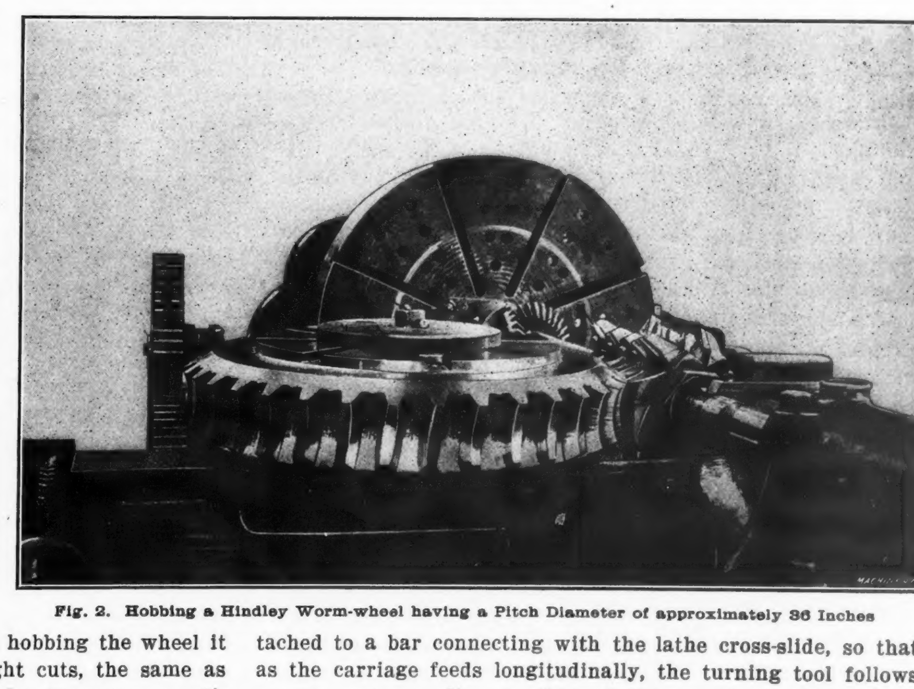


Fig. 2. Hobbing a Hindley Worm-wheel having a Pitch Diameter of approximately 36 Inches

The hob used for the work, owing to its large size, was made with a machine-steel body, and the teeth are faced with tool-steel cutters K. These cutters are one-half inch thick and are held in position by cap-screws and dowel-pins. The inner end of each cutter is also fitted into a slot at the bottom of the gash, which gives additional support. When making the hob, the body was first turned and threaded just like a Hindley worm of corresponding size. Seven gashes were then sawed out to form the teeth, and the cutter-retaining grooves were milled. The annealed cutters or faces for the teeth were then bolted to the hob body, after being roughed to approximately the required form. The hob was then placed in the lathe and the tool-steel faces finished to the correct shape by hobbing with the worm-thread finishing tools, the operation being similar to that followed for making a worm. After hobbing, the sides of the cutters were filed to the proper degree of clearance. The clearance angle is about three degrees, although it varies somewhat owing to the change in the angle of the teeth due to the hob curvature. The final operation was that of hardening the cutters and attaching them to the hob body. By making the hob with a machine-steel body, the danger of distorting or cracking it by hardening was eliminated. There is also an advantage in having detachable cutters, in that they can easily be replaced if necessary.

The final operation on the worm-gearing is that of grinding the teeth to remove any uneven spots or ridges that may have been left by the machining operation. This grinding is done by running the worm and gear together and applying brick-dust and water, which abrades the threads of the worm and teeth of the wheel and produces smoother and better bearing surfaces.

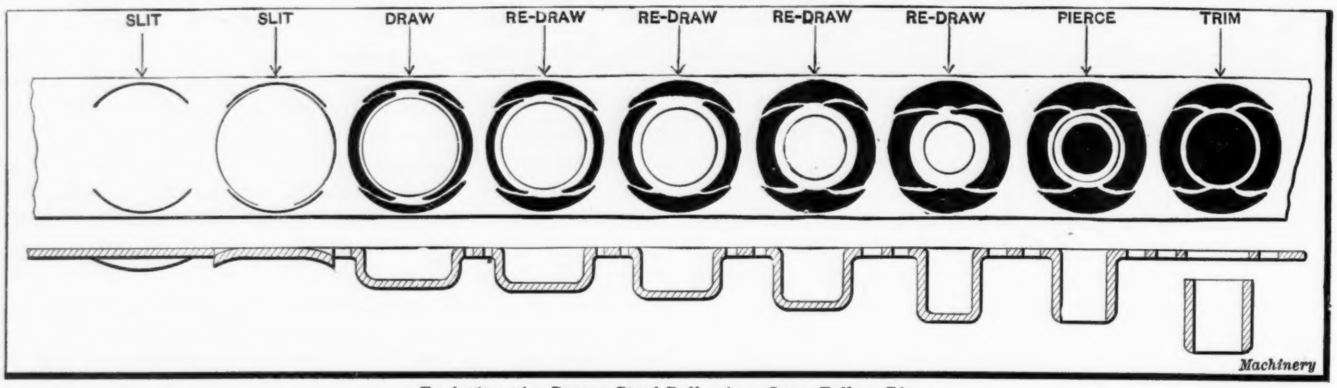
The blank for the worm is turned in a lathe equipped with a special attachment which gives the required curvature. This attachment operates on the same principle as a regular taper turning attachment. It consists of a guiding templet having a curved slot, the radius of which corresponds to that of the worm. Engaging this slot there is a steel roller attached to a bar connecting with the lathe cross-slide, so that as the carriage feeds longitudinally, the turning tool follows an arc corresponding to that of the templet. This tool is centered with the blank longitudinally and is set in the same horizontal plane as the axis of the work. The phosphor-bronze blank for the wheel is turned to the proper curvature by means of a special attachment which consists of a tool mounted in a holder in such a way that it can be turned about a vertical axis, when finishing the curved periphery of the blank.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in Machinery.

PRODUCING DRAWN STEEL ROLLERS IN A GANG DIE

The illustration presented herewith shows the writer's idea of a layout for the progressive and automatic production of small chain rollers in quantities ranging from 18,000 to 22,000 parts per day per unit equipment. By using stock considerably thinner than the walls of the finished roller are to be, and working upon it progressively by means of gang or follow-up dies, as shown in the illustration, the roller can be completely finished in the power press. The plan view shows the entire evolution that the shell goes through to produce the result shown at the right-hand end of the sectional view. The stock used is dead soft, cold-rolled steel, which can be fed to the die by means of an automatic roll feed. At the first stroke of the press, the metal to form the shell blank is slit radially on two sides, as shown at the extreme left of the plan view. At the next stroke of the press, the metal is fed over one die space and is again slit. The next stroke performs the first drawing operation. The fourth operation is a redraw which is also the case in the fifth and sixth operations. The seventh operation is a finish-sizing process. In the eighth operation, the bottom of the drawn shell is punched out. The ninth and final operation consists of trimming the free end from the stock, as shown at the extreme right of the sectional view.



Evolution of a Drawn Steel Roller in a Gang Follow Die

At this point, the shells are annealed and then placed in a hopper. They are then fed to compression dies which apply end pressure to the tubes, and expand the shell walls to the required thickness. This operation will size and finish the rollers in exact duplication and to accurate dimensions. It will be seen from the layout that the work is carried along in the stock until the last operation, which cuts it free in the manner previously described. The writer estimates that the approximate cost of each unit die equipment, exclusive of a single acting power press, equipped with automatic feed, would be $300. A No. 19 single acting Bliss power press equipped with a No. 2 standard double roll Bliss automatic feed, is recommended as machine equipment. Stock ranging from ¾ to 1½ inch in width, and from 1/32 to 3/32 inch in thickness is best suited for producing such work.

New York City. J. V. Woodworth

THE TASK IDEA

The reader of technical literature today is likely to get the impression that the "task" system is a modern institution. This, however, is not so, for there exist today in England many concerns who have used this system for probably a hundred years or more. It is not quite the same system, however, for although the fixed task is there, no bonus is paid if it is performed in a briefer space of time than that set.

Fifty years ago, the writer's father worked under this system which was in vogue then and is still used in a large iron foundry employing about one thousand men. Pipes of all kinds are produced. Long experience has allowed the average time on a job to be accurately gaged, so that the output which constitutes a fair day's work is well known to everyone concerned. Disputes seldom arise and strikes are unknown. What is termed "80 inches" of standard socket pipe for gas or water is considered a day's work for a gang of men, but the number of men to a gang varies according to the size of the pipes. The unit "80 inches" means ten 8-inch pipes, eight 10-inch pipes, two 40-inch pipes, and so on. The gangs begin work at six o'clock in the morning and continue until the task per gang is finished and cast. Any bad castings have to be made good the following day.

The advantages of this system are manifold to the workmen, particularly in the smaller gangs where differences of opinion less frequently arise than in the larger gangs. When the whole gang is composed of fairly intelligent men, they can by steady work finish the day's task early, and enjoy long evenings for recreation and self-development. If a man wants an hour or two off, he only needs the consent of the other men in the gang. This has been agreed to by the management; all that is required is that the day's task is completed—there is no interference with the way it is done. By hard work a gang can finish at two o'clock in the afternoon, the furnaces and cupolas being kept going practically the whole day. Three or four o'clock in the afternoon are common hours for leaving. The wages earned are from 15 to 20 per cent greater than those of the ordinary day-workers who work until five o'clock.

The writer is not at all certain that present methods are an improvement on the old-fashioned way. Is it not a fact that the hours of labor at present are too long to permit of really efficient work during the whole of the day? Mind and body become weary, resulting in general inefficiency. But little time and, at any rate, but little inclination remains to devote the evenings to the study necessary to increase efficiency. Ten hours a day is too much for any man working at a monotonous occupation; eight is ample, and, in the opinion of the writer, would produce better results, if not in the immediate future, certainly eventually.

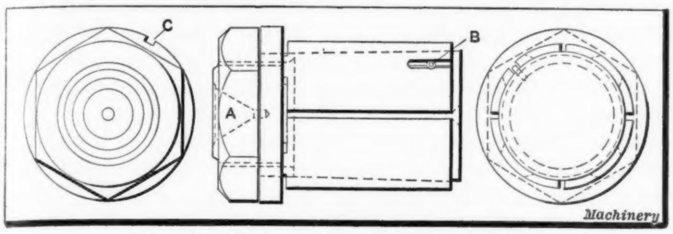
Time Limit

EXPANDING CENTER FOR TURNING HOLLOW SHAFTING

A useful type of expanding center for use in turning hollow shafting, castings, or similar work, is shown in the illustration. It consists of a taper plug upon which a split shell is accurately fitted. In using this device, the lathe center fits into the hole *A*. The center is placed in the work and the split shell is then expanded through the action of the nut at the end of the plug. The pin *B* prevents relative rotation between the plug and shell, while the shell itself is held by a spanner fitting into the slot *C*. It will thus be evident that when the nut on the block is tightened, the shell is forced in on the taper and expands sufficiently to fit the work. When it is desired to disengage the block, the nut is slacked off. A sharp blow is struck on the end of the plug with a lead hammer. The center can then be as easily withdrawn as it was put into place.

These expanding centers have been found very useful on

many classes of work where the hole is too large to admit of the use of the regular lathe centers. They have been used in turning crankshaft parts, thrust, intermediate and tail-shafts for the steamship *Minnesotan*, the first of eight steamships now being built at the Maryland Steel Co.'s plant at



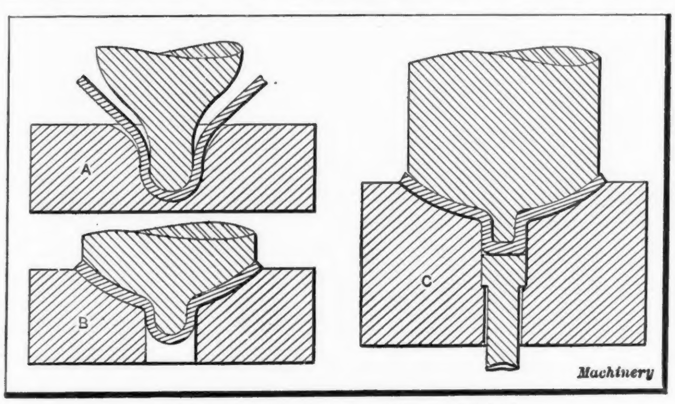
Expanding Center for Turning Hollow Shafting

Sparrows Point, for the American-Hawaiian Line. The work turned on this type of center is found to be as accurate and free from chatter as if the work were carried on the regular centers. LEWIS SYKES

Baltimore, Md.

DRAWING A SMALL SHELL FROM THICK BRASS

The shell shown in section in the dies at *C* in the illustration, is an unusually difficult job to draw from thick brass, the principal difficulty being due to the fact that the metal will not draw over anything approximating a sharp corner. The usual method of producing a shell of this kind—reducing it from larger cups by successive drawing operations—was tried without success. Finally the method shown in the illustration was hit upon, and it was found that satisfactory results could thus be obtained. This makes the operation akin to squeezing rather than drawing, the point being to protrude



The Three Dies used to produce the Shell

enough metal in the first and second operations to allow pressure from below to be applied in a third operation, shaping the stock and setting it to the required dimensions.

In the dies shown at *A* the object is to start the thick metal in a downward direction by means of the comparatively loose fitting punch and die shown. The edge of this die is very gradually rounded so that the metal will slide over easily. The second operation, which is performed in the dies at *B*, consists of shaping the shell around the depression already made, and the finished shape is the result of the operation performed in the dies at *C*.

The shell is started from a round blank, and two annealings are required to bring the metal to the finished shape. Subsequent piercing and cutting operations are afterward performed on the piece, but these do not differ from the general run of such operations.

Columbus, Ohio. OTTO R. WINTER

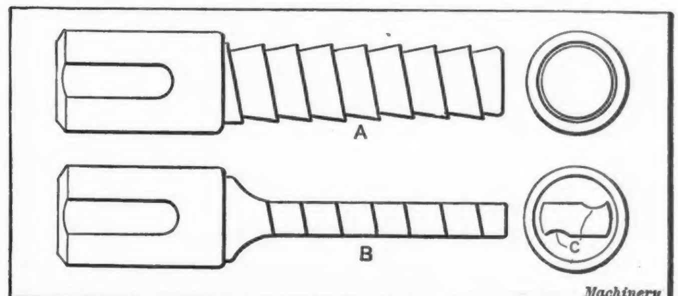
CHROME-VANADIUM STEEL FOR SCREW-DRIVERS

Screw-drivers made from properly heat-treated chrome-vanadium steel will be found superior to those made from other materials. Properly heat-treated chrome-vanadium steel possesses the hardness necessary to prevent the point from twisting off, and at the same time has enough toughness to prevent nicking or cracking; its torsional strength is exceptionally high. Actual tests have proved that when used for screw-drivers no material is superior to this steel. The heat-treatment should be as follows: Heat to from 1600 to 1650 degrees F., and quench in oil; then draw to from 700 to 800 degrees F.

Sandover, Md. W. A. SHERWIN

ROUGHING REAMER FOR CHROME-NICKEL STEEL GEAR BLANKS

Considerable trouble was met with in reaming tapered holes in certain chrome-nickel steel gear blanks. Several types of reamers were furnished by tool experts, but the results obtained were unsatisfactory. Finally, the type of roughing reamer shown in the accompanying illustration was devised. The blank for this roughing reamer was turned to the proper taper, but 0.005 inch smaller than the finishing reamer. A buttress thread of 1/2 inch lead was then cut on the reamer part, as shown at *A*, after which the blank was placed between



A Roughing Reamer used for reaming Holes in Chrome-nickel Steel

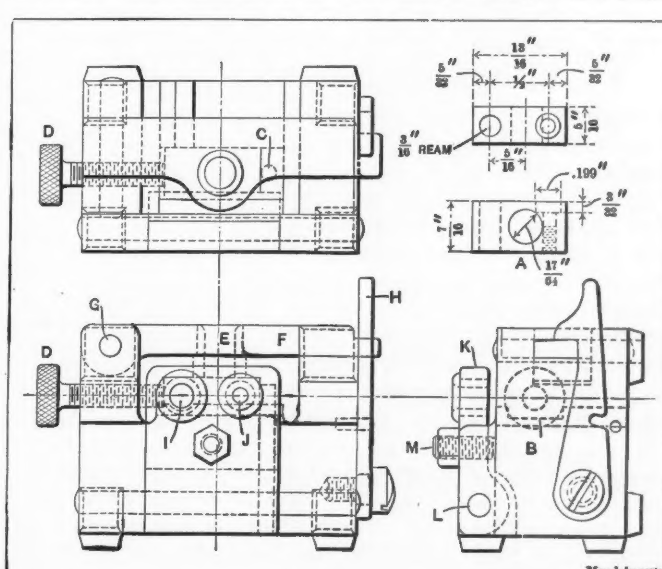
the centers in the milling machine and milled as shown at *B*; the cutting edges were then given the proper rake by milling two parallel grooves, as indicated at *C*. When removed from the milling machine, the reamer was finished by giving it the necessary relief on the cutting edges with a file.

This reamer was fed at a rate of 0.020 inch per revolution of the spindle, and after having reamed the hole with it, a finishing reamer of standard shape was used at slow speed, with a feed of 0.010 inch per revolution of the spindle. This reamer left a nicely finished hole.

Lafayette, Ind. W. H. ADDIS

DRILLING, REAMING, COUNTERBORING AND TAPPING JIG

A simple but very efficient jig for drilling, reaming, counterboring and tapping a part for a typewriter is illustrated herewith. The work shown at *A* in this illustration is a small



Jig for drilling, reaming, counterboring and tapping Piece A

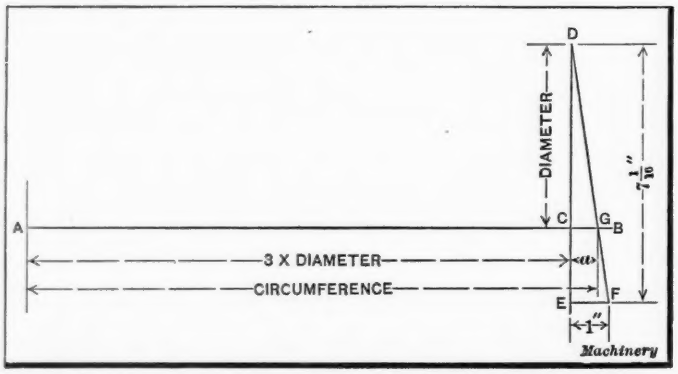
machine-steel block. This block is laid in a groove *B* in the body of the jig and is held against the locating pin *C* by means of the set-screw *D*. The work is held down by the head of the bushing *E* which is carried by the leaf *F*. This leaf swings

on a pin G and is clamped shut by the latch H. The largest hole is drilled through the bushing E, while the other two holes are drilled through the bushings I and J, which are carried in the second leaf K at the side of the jig. This second leaf swings on a pin L, but is not clamped shut. When closed, the adjusting screw M keeps the leaf in the correct position. After the three holes are drilled, the side leaf is lifted and one hole is reamed and the other counterbored and tapped. No guide bushing is used for the latter operation.

A. M. ROCHESTER

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE

The accompanying illustration shows a method by means of which the circumference of a circle can be laid out along a straight line, simply by using a scale. The method gives very accurate results. Lay out on line AB the distance AC equal to three times the diameter of the circle. At C erect



Method of Laying Out the Circumference of a Circle along a Straight Line

a perpendicular CD equal to the diameter of the circle; extend DC to E (if necessary), so that DE equals 7 1/16 inches. Draw EF perpendicular to DE, making it 1 inch long; draw DF, intersecting AB at G. (Should point F be located on the upper side of the line AB, extend DF until it intersects AB at G.) Line AG then represents the circumference of the circle.

Since the triangles CDG and DEF are similar, we have:

$$1 : 7\,1/16 = a : \text{diameter}.$$

Hence $a = (1 \div 7\,1/16) \times \text{diameter} = 0.1415929$, and $AG = 3.1415929 \times \text{diameter}$. Since the circumference of a circle is equal to $3.1415926 \times$ diameter, this method is, theoretically, almost exact, the error being too small to be taken into account for any practical purposes.

W. L. TRYON

Schenectady, N. Y.

THE VALUE OF AN EFFICIENT TRUCKING SYSTEM

It is surprising to note how little attention is paid to the method of handling work in some factories. These are generally the establishments which complain most of the heavy item which overhead expense makes in their cost of production. The argument is advanced that trucking is non-productive labor, and consequently does not need so much attention. This statement, however, is far from accurate.

In a certain large factory engaged in the manufacture of sheet metal products, the method of transferring work from shop to shop was seriously neglected. It was the practice to allow the machine operators to move their own work from department to department. Sheets of metal were loaded on trucks to carry them from one machine to the other, the trucks being unloaded before each operation was started. It will be evident that this method was responsible for a serious loss of time, and when this fact was recognized the mistake was corrected by adding fifty new trucks to the shop's equipment. These trucks were placed at the disposal of the men and orders were issued that all material should be kept on the trucks. This meant that each machine had two trucks; one to take away finished work and the other loaded with raw material. It may seem that the presence of so many large trucks would take up too much floor space, but the results do not show that this was the case, as the room occupied by the trucks was formerly taken up by piles of material and finished product.

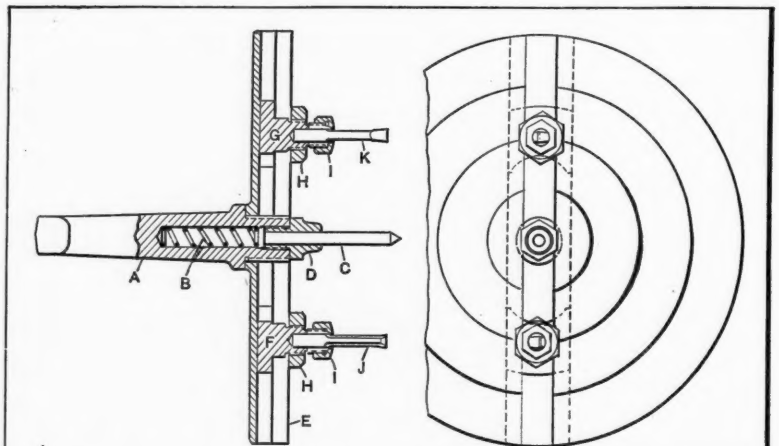
An important point in the development of the new trucking system was the maintenance of an aisle in each room, wide enough for two trucks to pass. The machines were arranged in progressive order on each side of the aisle, the men being required to keep the aisle-space clear. Instead of having the machine operators do their own trucking, a corps of truckers was employed under the direction of a floor manager, whose duty it was to keep the materials constantly moving from machine to machine as the various operations were completed. This floor manager ordered his raw materials from the yards and moved the work along through the departments as rapidly as possible. This kept each machine running continually and reduced the overhead cost to a great extent, owing to reduction in the amount of time which the equipment was idle.

New Britain, Conn. J. M. HENRY

TOOL FOR CUTTING OUT RINGS OR DISKS FROM FIBER SHEETS

The tool shown in the accompanying illustration was designed for cutting out fiber rings or disks from the sheet, forming both the hole and the outside diameter in one operation; when desired, it can be used for cutting out the blanks only. The shank A of the tool is supplied with a Morse taper to suit a drilling machine spindle, and a hole is drilled in its lower end to receive the spiral spring B and plunger C, the lower end of the latter being cone-pointed. The top end of the plunger is provided with a head which acts as a stop for the plunger, coming against the threaded bush D screwed into the lower end of the shank A; this bush also acts as a guide for the plunger.

A disk E (which in this case is 5 inches in diameter) is screwed onto the lower end of the shank, and has a T-slot milled across its face to retain the tool-holders. The tool-holders F and G are made from a square bar, bored to receive a piece of round tool steel. The outsides of the tool-holders are turned, threaded and fitted with nuts H, which hold them in position in the disk E, when set to the required radius. The lower ends of the tool-holders are turned,



An Adjustable Tool for Cutting out Rings or Disks from Fiber Sheets

threaded, tapered and split, and are fitted with nuts I forming a split chuck for holding the cutting tools J and K. These tools J and K may be made in various lengths to suit the thickness of fiber to be cut.

The lower face of the disk E is provided with circles of various diameters and is marked so that the tool-holders may be readily set to cut any given diameter. The plunger C is so arranged that when pressed out by the spiral spring B to its extreme length, the point of the center projects about 1/8 inch in advance of the cutting edges of the tools. In using this tool, the fiber is marked with a center punch, the punch mark being located far enough from the edges of the sheet so that the cutters will not break out. The tool is placed in the spindle of a drilling machine and rotated at a good speed

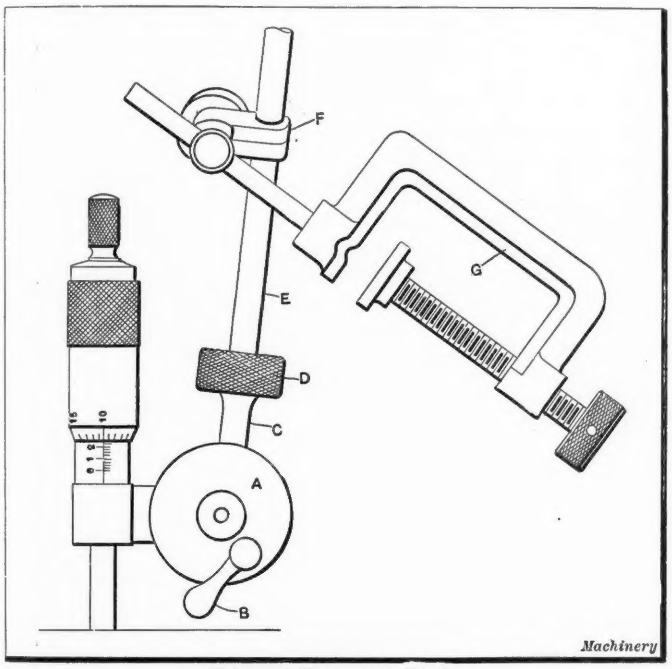
(say 1000 R. P. M.), the fiber being placed on the table of the machine with a thin board beneath it to protect the cutters when they pass the sheet. As the cutters are brought down toward the fiber, the center C which projects a little in advance of the cutters, comes into contact with the work first; this enables the fiber to be moved into the correct position, before the tools commence to cut, without stopping the machine.

When rings are required to be cut out, the inside cutter, or the one which is cutting out the hole is adjusted to cut the blank out of the ring before the other cutter separates the ring from the sheet; this insures the clean cutting out of the bore, and prevents the ring from being carried around by the cutter which is cutting the bore. The spiral spring behind the center, being stiff, holds the portion which is cut out first quite firmly in position, while the ring is being separated from the sheet. When cutting out blanks one of the cutters is removed. LAWRENCE W. WILLIAMS

Handsworth, Birmingham, England.

UNIVERSAL MICROMETER DEVICE

The writer has long felt the need of a micrometer device which would make it possible to remove surfaced work from the shaper, planer or milling machine and to replace it accurately. For this purpose, the tool illustrated in the accompanying engraving was devised. A standard 1-inch micrometer is used with the anvil part of the frame removed. The friction disk bearing A is mounted onto what remains of the frame, at right angles with the micrometer spindle. This bearing can be locked by handle B. Stud C is inserted in the disk bearing A; this stud is threaded to fit nut D. The support E is provided with a collar at one end that fits into nut D, this arrangement making it possible to use different types of supports. The purpose of nut F and clamp G is apparent from the illustration. The device can be clamped to any stationary part of the machine, and as it is universal in its adjustment and the micrometer spindle has a range of one inch, it is a very valuable tool for the machinist and toolmaker. WM. H. ADDIS

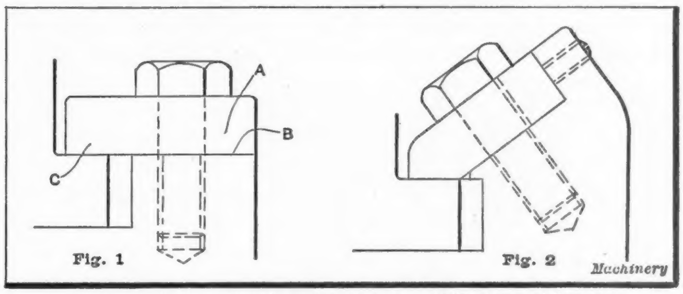


Universal Micrometer Head

La Fayette, Ind.

DESIGN OF SQUARE GUIDE FOR SLIDES

Undoubtedly the square slide is to be preferred to the V-guide when friction and wearing qualities are considered, but the objection to its wider adoption is the difficulty of adjustment of the strip A in Fig. 1. On some slides where the wear is small this defect is not of much consequence, but on slides such as used for shaper rams, where the wear is great, the design presents a great drawback. In addition, the cost of fitting and adjusting the slide on a new machine, if a good fit is required, is objectionable. The only way of adjusting the strip is by carefully removing metal from the surface B until the required fit is reached. This lack of adjustability is also a bad feature when the machine has become worn through use. Because of the trouble involved in adjusting the strip, the machine is frequently allowed to run until it is in very bad shape.

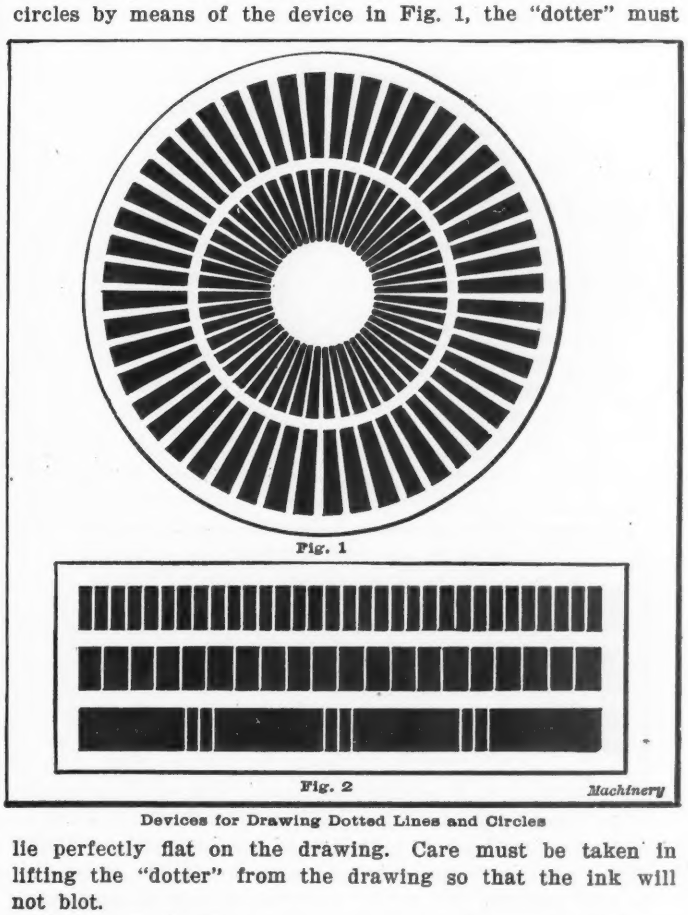


Figs. 1 and 2. Conventional and Improved Designs of Square Guide for Slides

The arrangement shown in Fig. 2 was intended to overcome the weak points of the design shown in Fig. 1, while still retaining all the good points. The construction can be quite massive, and as the bolt heads are practically over the heads of the thrust, there is little chance for looseness of the fit. The adjustment is very simple, and the ease of fitting is apparent. A. H.

DEVICE FOR DRAWING DOTTED LINES

The accompanying illustration shows the principles of a device for drawing dotted lines. It is well known that it requires considerably more time to trace dotted lines than to draw full lines and circles. The devices illustrated are made from thin sheets of amber or celluloid. The parts shown in black are cut out so that the pen will touch the paper at these points. The length of the dots and dashes can be regulated by the spacing of these sections. When drawing a dotted line, the T-square or triangle is simply placed over the "dotter" (Fig. 2) and the line is drawn as if it were a full line, without lifting the pen. When drawing dotted circles by means of the device in Fig. 1, the "dotter" must lie perfectly flat on the drawing. Care must be taken in lifting the "dotter" from the drawing so that the ink will not blot.



Devices for Drawing Dotted Lines and Circles

McKees Rocks, Pa. AUGUST H. ANGER

[It would seem difficult with a device of this kind to prevent the ink from flowing along the edges of the celluloid

and also that it would be almost impossible to lift the disk from the paper without causing ink blots. The idea was tried in this office, however, and found to work fairly well.—Editor].

FILING MACHINE BRACKET

The accompanying halftone shows the application of a special holding-down bracket used on a filing machine made by the Simplex Mfg. Co., in order to increase the range of work that can be handled on the machine. The arm is shown in detail in the line engraving Fig. 2. It is supported from the column of the machine and held in position by a clamp hub, and is as universal in its adjustment as the holding-down clamps furnished with the machine. Two offset fingers are used for clamping purposes. The use of this bracket makes it possible to keep the table clear for any class of work. After the fingers are set to accommodate the thickness of the work at hand, no further adjustment is required. One of the two ordinary clamps is also shown on the table in Fig. 1, merely to illustrate its appearance and application.

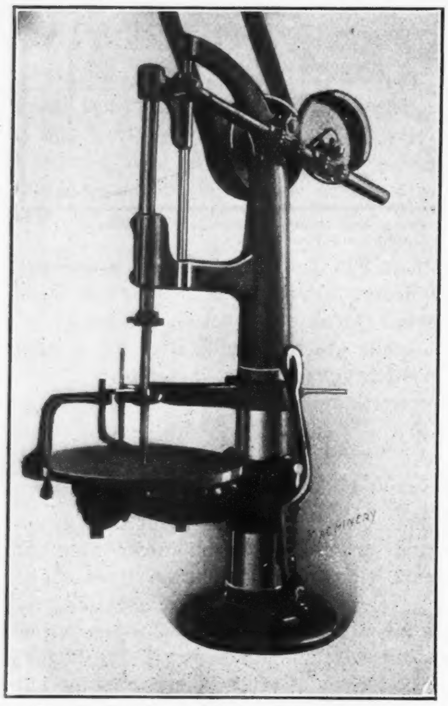


Fig. 1. Bracket applied to Filing Machine

The advantages of the bracket are particularly in evidence in cases where it is required, for example, to file a set of cams for a Brown & Sharpe automatic screw machine. The whole table of the filing machine would be unobstructed and any part of the cam could be filed without adjusting the holding-down clamps. On all kinds of dies and punches it is also especially useful for filing a circular portion. It is often desirable to be able to swing the work through a large arc, which this special bracket permits.

D. Sign

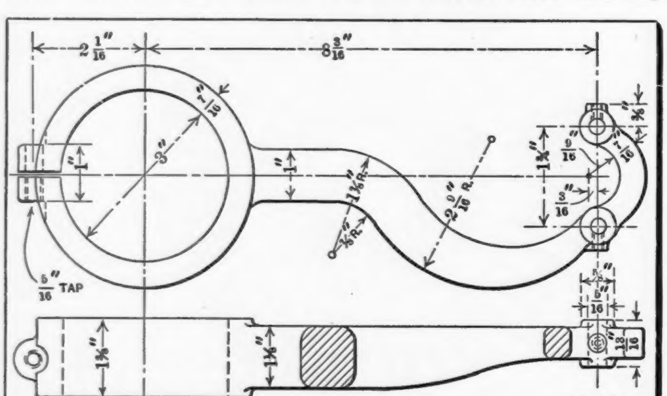


Fig. 2. Dimensions of Bracket

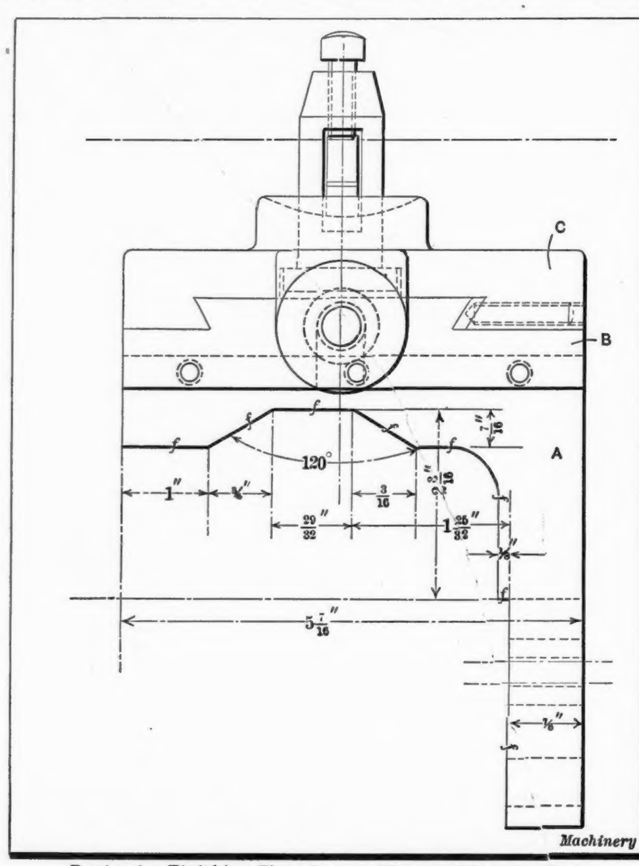
USING GASOLINE ON TRACING CLOTH

It is probably the most common practice in drafting-rooms to use powdered chalk or some similar preparation to absorb the greasy element on the surface of tracing cloth. While the results obtained are satisfactory so far as the object in view is concerned, the gritty preparation rubbed over the cloth will dull the finely sharpened edges of the ruling pen in a comparatively short time. For this reason it is preferable to rub the tracing cloth with a soft cloth slightly dampened with gasoline. When this practice is followed the ruling pen will be found to remain sharp much longer than when the tracing cloth is rubbed with chalk. Gasoline is also useful as an eraser for lead pencil marks and for cleaning a soiled tracing before removing it from the drawing-board.

Manchester, N. H. Clarence Kent

TOOL FOR FINISHING THREADS ON A THREAD MILLING MACHINE

The accompanying engraving shows a device used for finishing threads on a Pratt & Whitney thread milling machine. By means of this device objectionable milling cutter tooth marks can be removed whenever they become very apparent on the work, as, for example, when maximum feeds are used with such materials as cast iron, bronze and soft steel. The device consists of a bracket *A*, fitted to the carriage of the machine and bolted to the seat used for carrying the follow-rest on regular long work. The bracket bears on the top of the cutter-slide which is planed to an angle of 120 degrees. Mounted on this bracket is a slide *B*, parallel to the work.



Device for Finishing Threads on a Thread Milling Machine

This slide has provision for adjusting the finishing tool to the threads already roughed out by the milling cutter. This adjustment is accomplished by means of two fillister-head screws, one at each end of the slide. Attached to this slide is the top slide *C* in which the shaving or finishing tool is clamped. This latter is made from 3/8 by 3/8 inch stock, and is held in a regular toolpost. The top slide is operated by a small handle located immediately above the handwheel which operates the cutter-slide. This handle is provided with a graduated dial reading to 0.001 inch.

When this device is used, the milling cutter is fed into the work and the work roughed out to within from 0.002 to 0.004 inch of the finish size. The finishing tool is then brought into action, removing the remaining stock and leaving a smoother finish than could be obtained by milling alone with a heavy feed.

J. E. Sheuman

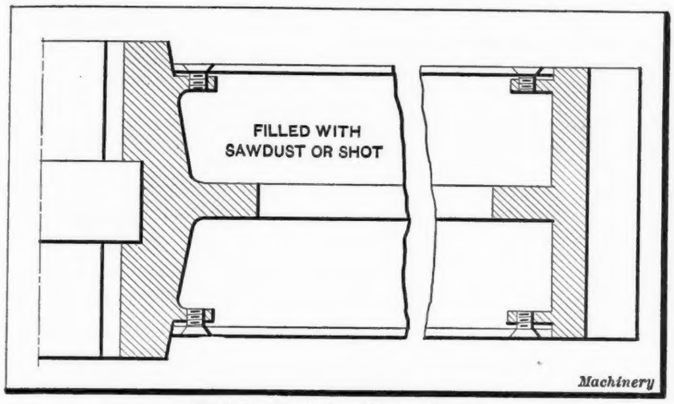
Waynesboro, Pa.

ANOTHER CURE FOR NOISY GEARING

In the May issue of Machinery, a cure for noisy gearing is mentioned which appears to combine the advantages of low cost and efficiency. The following method which is used

on a large scale in some engineering works in St. Petersburg, Russia, is even more efficient, but it is also far more expensive.

In using this method gears of less than 18 inches in diameter are fitted with two sheets of tin which enclose the space between the hub and the rim of the gear. This space is then filled with sawdust or with No. 4 shot, the idea being to eliminate vibration by this means. In some cases, it has been found advantageous to use a mixture of shot and sawdust. The sheets of tin are fastened to the rim and hub with a number of small screws, as shown in the illustration. When



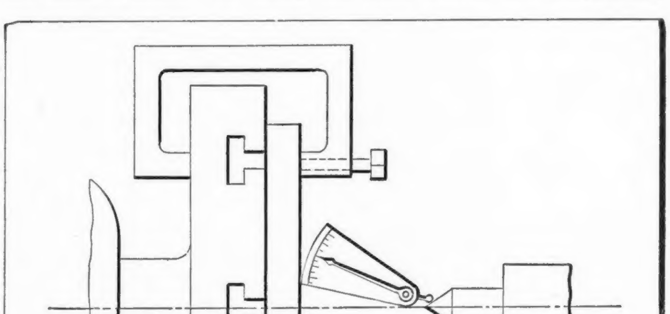
Method of Quieting Noisy Gears

the diameter of the gears exceeds 18 inches, wooden rings are used in place of the tin, the method of attachment being similar in either case. A felt packing is used to prevent the sawdust from leaking out. This arrangement has the further advantage of closing the space between the spokes of a wheel, thus making it impossible for a workman to get his arms or tools caught by the rotating wheel.

Wolverhampton, England. A. WIND

TESTING THE ALIGNMENT OF LATHE CENTERS

The writer once desired to know the alignment of the dead center of a lathe in which he had a piece of work mounted. This work was of an awkward shape, and after clamping it to the faceplate it was found necessary to bring the dead center forward to a hole which had been drilled, to assist in holding the work. When the lathe was started, a slight vibration of the center hole showed the center to be out of line with the lathe spindle. To bring the dead center into alignment,



Method of Testing the Alignment of Lathe Centers

a test indicator, graduated to read in thousandths, was clamped to the faceplate, in such a position as to enable the indicator point to come into contact with the end of the center. This is clearly shown in the illustration. When the lathe spindle is revolved under these conditions, the amount of error in the alignment of the dead center is accurately shown. This error can then be easily remedied.

This is a useful method of lining up centers before starting to turn a straight piece of work. It is far superior to the practice of taking trial cuts and making the necessary measurements and adjustments between cuts, in order to ascertain whether the piece will be straight when finished. Almost every tool-room has some kind of test indicator which is capable of being used for this purpose. F. E. C.

A STEADYREST NOVELTY

In the July issue of MACHINERY, E. W. Tate has a tilt at the steadyrest proposed by H. Terhune in a previous issue. He enumerates several rather visionary faults, and sets out to abolish them with a design which appears to me to perpetuate rather than remedy the very points he criticises in H. Terhune's design. And it was rather unfortunate, after complaining of the cost of the first design, when he confessed that the application of his own is limited on that account.

This controversy and the editor's trenchant footnote anent the neglect usually accorded these accessories has prompted me to advance a description of a type of steadyrest which is, as far as I know, quite novel, and which is both compact and cheap. This steadyrest can be made in two styles, as shown in Figs. 1 and 2, according to whether the screw is required to work the jaws both ways or not. The construction in

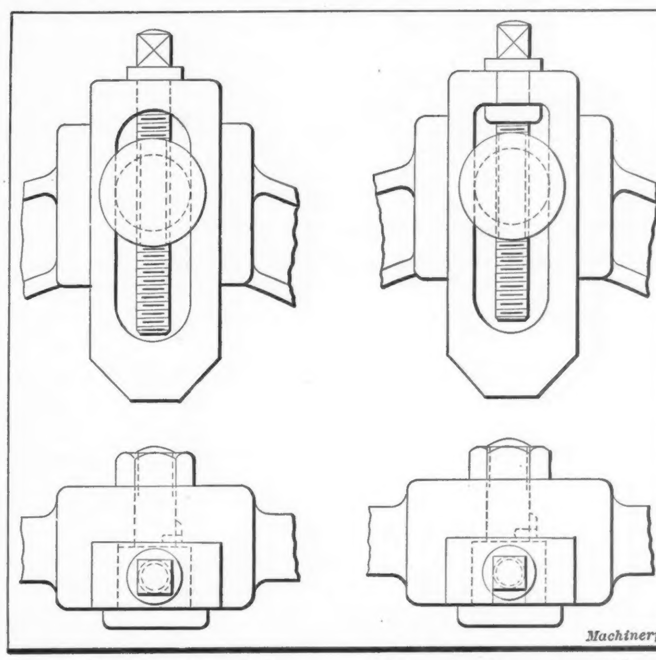


Fig. 1. Steadyrest to work Jaws in One Direction   Fig. 2. Steadyrest to work Jaws in Two Directions

each case is practically identical, the difference being that the type shown in Fig. 2 has the screw turned with a second collar, and the hole for the screw in the top of the jaw is milled out to the front. There are no unsightly screws projecting when the jaws are fully out, as in the case of many of the types now in use. The machining of the jaw guides can be done by an ordinary milling cutter going straight through, instead of end-milling them, which is now necessary with the blind end guides. A. H.

PUNCH AND DIE FOR FORMING ELECTRIC TERMINALS

The punch and die shown in Fig. 2 were designed for forming electric terminals of the type shown in Fig. 1. The arrangement has been so worked out that two terminals are formed and two others sheared off by each stroke of the press. The stock

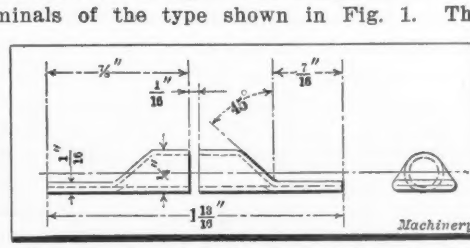


Fig. 1. Two Electric Terminals after being cut apart

used is copper tubing, ¼ inch in diameter with a wall about 1/32 inch thick.

Reference to the cross-sectional view of the punch and die

shown in Fig. 2 will enable the operation to be readily understood. In this illustration *A* is the punch which forms the work in the die *B*. The shear *C* is bolted to *A* and backed up by a shank to enable it to withstand the blow. The right-hand face of the die *B* acts as the lower shearing plate. *D* is a square block of tool steel which is used to straighten out the formed tube before the punch *A* descends for the next stroke upon the unformed section of the work. The use of this block has been found necessary to bring the flat portions of the double terminal into proper alignment. When the shear *C* is in the act of descending, distortion of the formed tube would be inevitable were it not for the action of block *D*.

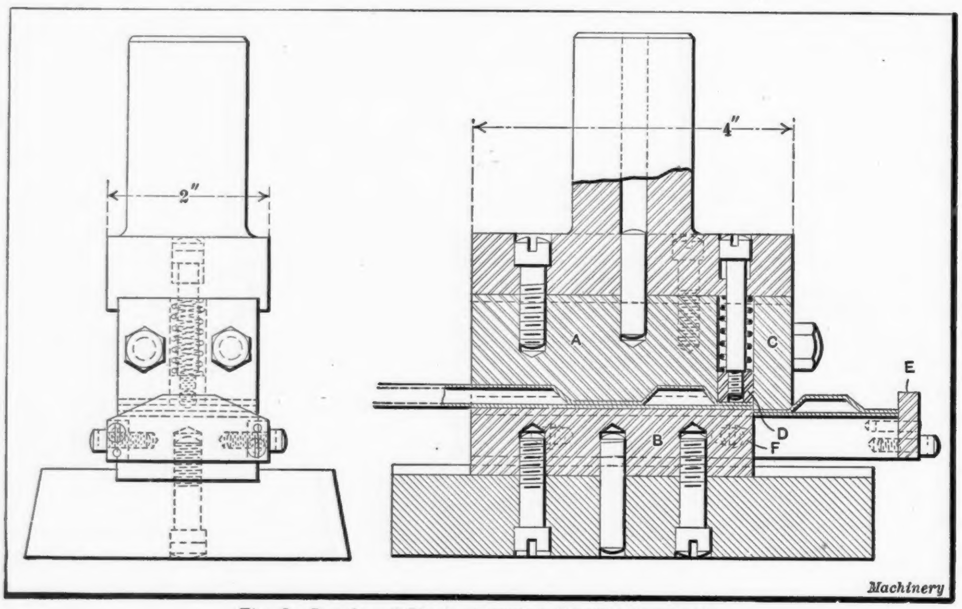


Fig. 2. Punch and Die for Forming Electric Terminals

The work is fed through the die until it comes up against the stop *E* which can be adjusted by means of screws *F* that are located in a suitable elongated hole. With the work in position against the stop *E*, the punch descends, shearing off the end of the stock and forming a double terminal between the punch and die. The work is now advanced to bring it into contact with the stop *E* and the punch is again tripped. This shears off the pair of terminals which were formed in the preceding operation, and at the same time a second pair is formed in the die.

After the terminals are sheared off, they are put into another die and the hole in each end is pierced. They are then run over a saw which cuts them exactly in half, as shown in Fig. 1. Two terminals are thus produced from each piece which is sheared off by *C*.

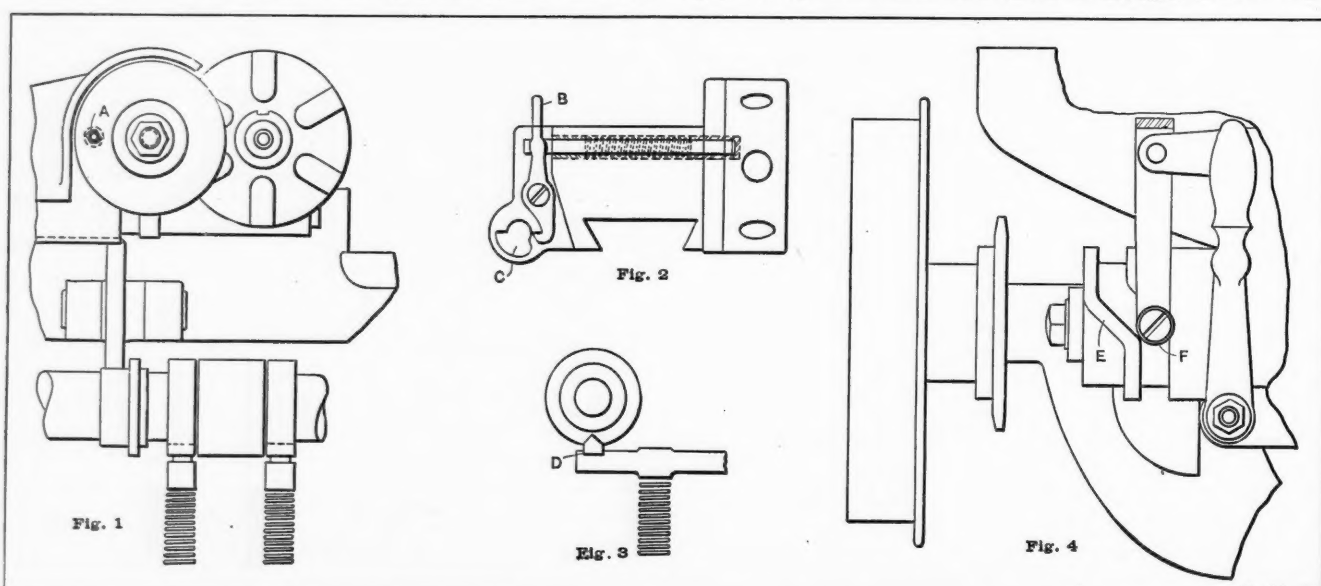
Chester, Pa. CHARLES R. ENGEL

TAKING OUT BACK-SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

In every screw machine department equipped with Brown & Sharpe automatic machines, it is necessary to take out the back-shaft of at least one or two machines a week. The back-shaft is located in the rear of the machine and carries the various operating gears and clutches, the entire machine being operated therefrom. The reason for removing the back-shaft has nothing whatever to do with the design of the machine, since it is taken out for the sole purpose of removing the gummed oil, etc. In the following, the writer will describe the only practical and correct method of removing the back-shaft, which is a very important item in the training of any screw machine operator.

If a back-shaft is taken out and replaced in such a manner that every gear does not mesh with the same teeth as it did before the shaft was removed, then the machine will be "out of time," and the entire job will have to be set up again. If all the rules stated in the following are not observed when replacing a back-shaft, the machine, although it appears to be running all right, will be running under conditions which will probably cause breakage.

Some screw machine men, when about to remove a back-shaft, mark the gears with a center-punch which is not very satisfactory after the shaft has been removed several times. Fig. 1 shows the first thing to be done when about to remove a back-shaft. The roll on the turret operating disk, the clamp nut of which is shown at *A*, should set in line with the center of the turret. The machine should be operated by hand until this effect is brought about. Fig. 2 shows a view of the turret looking from the spindle; the cam *C* should be set as shown with regard to its radial drop. This cam is used for operating lever *B*, which unlocks the turret.



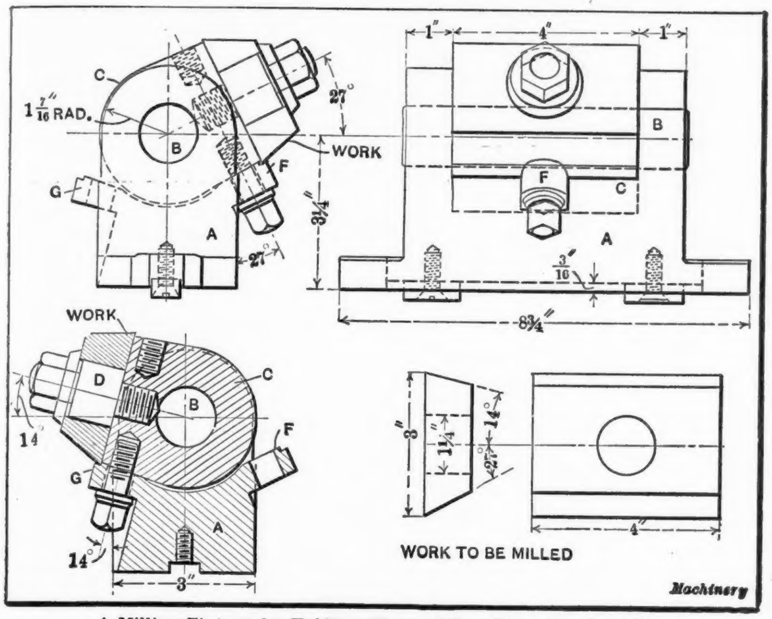
Figs. 1 to 4. Method of Taking Out the Back-shaft of a Brown & Sharpe Automatic Screw Machine

Fig. 3 shows how the clutches on the back-shaft should be set—with the notch down and engaged with the lever *D*. In Fig. 4 is shown a front view of the machine, in which the starting lever will be recognized. The cam for opening the chuck and operating the feeding of the stock is shown at *E*; *F* is the roller which rides on this cam and is shown in the position in which it should be set. When all these conditions have been observed it is safe to take out the back-shaft.

NEVIN BACON

MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed for holding the cast-iron piece shown in the lower right-hand corner of the engraving. This piece has its sides milled off at different angles as indicated. The fixture consists of a base casting *A*, the flanges of which are bored out to admit shaft *B*. This shaft passes through the center casting or work-holder *C* and allows it to turn freely from stop *F* to stop *G*. In the upper left-hand corner of the engraving is shown the position of the work in the fixture when milling



A Milling Fixture for Holding Work while milling Beveled Sides

the 27-degree side on the work. The center block *C* is held in position while milling by a screw passed through the lug *F*. The sectional view indicates the position of the work in the fixture when milling the 14-degree side. The work itself is held to the center block *C* by a stud *D* provided with a nut and collar.

Cincinnati, Ohio HENRY FRANZ

MEASURING SCREW MACHINE CHIPS

A common practice among screw machine workers is to measure the thickness of the chips to determine the feeds of the tools. The writer wishes to point out that this practice is misleading because of the tendency of the metal to compress in one direction and swell and stretch in the other, when separated from the bar by the cutter. In order to obtain data on the difference between the feed of the cutter and the thickness of the chips, some tests were made on a Brown & Sharpe automatic screw machine. A cam, the exact size and travel of which was known, was placed on the machine, and the machine was geared to rotate the cam at a given speed. The exact speed of the spindle was also determined, and in this way the exact feed of the cutter was known.

These tests showed that a form tool, ¼ inch wide, having a feed of 0.001 inch per revolution, cut a chip which measured 0.0025 inch when cutting brass, while a form tool ⅝ inch wide, with a feed of 0.0015 inch per revolution, cut a continuous chip 0.005 inch thick. A cut-off tool ⅛ inch wide, cutting brass and fed 0.001 inch per revolution, produced chips from 0.0015 to 0.002 inch thick. The proportions between the feed and the chip for the turret tools were slightly greater than for the cross-slide tools; that is, the chip expanded slightly more. The tests for steel indicated a smaller expansion than for brass.

Many times a cam designer is criticized by the operators for providing excessive feeds when this is not really the case, the apparent error being due to the erroneous method used by the operators in measuring the feed. The error that would result in the design of cams if the draftsman worked to data obtained by measuring the chips is, however, apparent.

NEVIN BACON

ERASING INK MARKS FROM TRACINGS

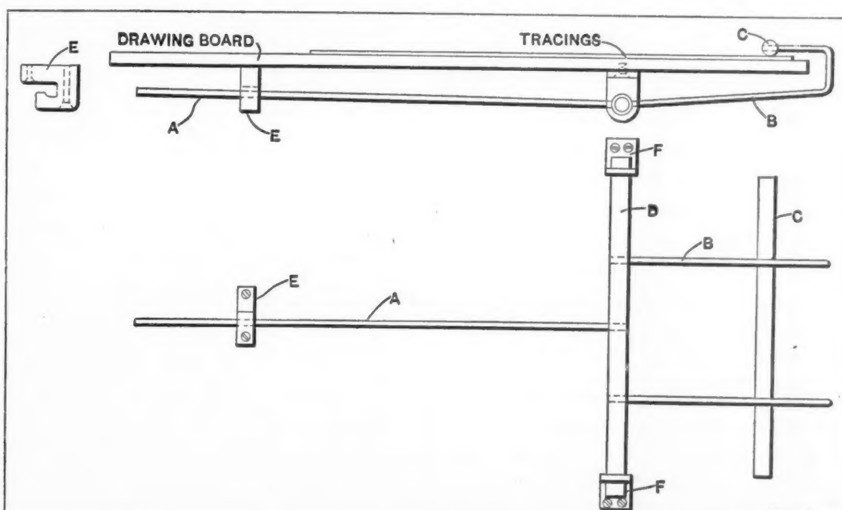
The writer wishes to add a few remarks to the discussion concerning the erasure of ink marks from tracings which appeared in the issue of MACHINERY for September. It will be found that the use of an ordinary pencil eraser on tracings will give better results than an ink eraser. The ink eraser will burn the tracing, as Mr. Allison states, if care is not taken in using it; this difficulty will not be experienced with a pencil eraser. Although a pencil eraser does not give as quick results, it will leave a much better finish on the tracing, and the use of soapstone will be unnecessary. If, however, a heavy line is to be erased, it will be found advisable to start with an ink eraser and then finish with a pencil eraser. A rather large detail can be changed on a drawing in this way, without leaving any noticeable mark. All that is required is a little patience. A. H. MYERS

York, Pa.

DRAWING-BOARD CLAMP FOR TRACINGS

When a great many tracings are used on the drawing-board at the same time, as, for example, when an assembly drawing is made, considerable trouble is experienced on account of the tracings sliding off the board. The accompanying illustration shows a special clamp made to take care of this difficulty. The tracings are placed beneath a maple stick *C*, which is located at the top of the drawing-table near the right-hand side. The clamping rod *A* is swung into the bracket *E*, and the drawings are held tightly in place. As each drawing is used it is thrown over the back of the table, the clamp still holding it in place. When a drawing is to be removed, rod *A* is taken out of the bracket, thus removing the pressure of the clamp rod which is immediately raised from the drawing-board on account of the rod *A* being the heavier part of the device. Any number of drawings can then be removed without the draftsman leaving his chair, thus saving considerable time.

Rods *A* and *B* are made of ⅜-inch cold-rolled steel and are driven into a 1-inch pipe *D*, and riveted. The maple rod *C* is 1½ inch in diameter, rods *B* being driven into it. Bracket *E* is also made of maple and is fastened to the table with two screws. Brackets *F* are made of cold-rolled steel and screwed to the board. As will be realized from the foregoing description, the whole outfit can be simply and easily made.

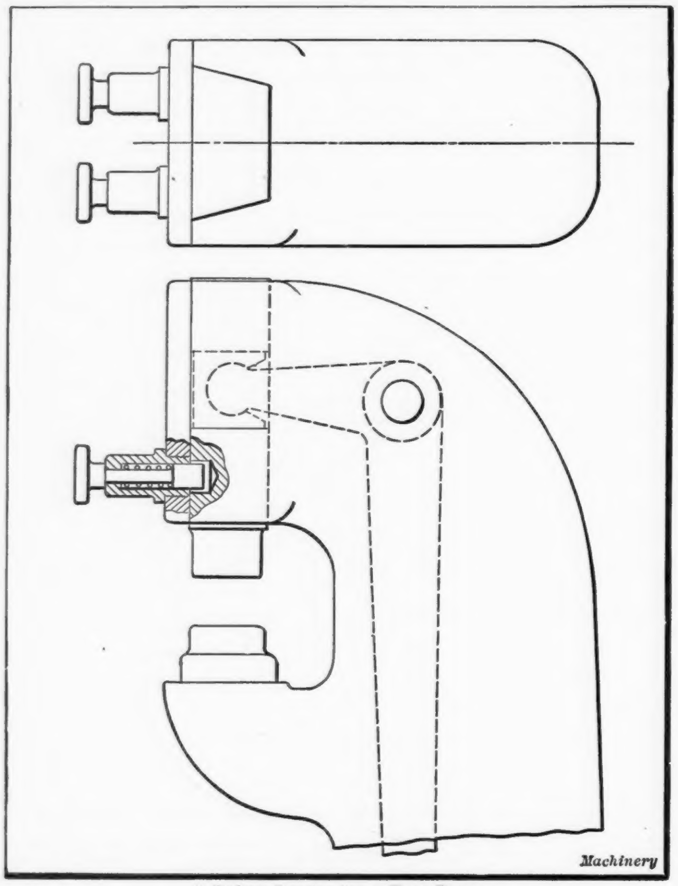


Arrangement for Clamping Tracings used for Reference to the Drawing Board

F. A.

SAFETY DEVICE FOR FOOT PRESS

In a certain shop where presses were operated by foot power, the girl operators constantly got their fingers trapped between the work and the punch. Whenever this happened, if blood was drawn, about one-half of the girls were inevitably rendered useless for some time; some even fainted at the sight. Hence, it became necessary to devise a safeguard. The simple scheme shown in the illustration was adopted.



A Safety Device for a Foot Press

Two spring plungers were used which remained in the holes in the ram until they were drawn out. As both hands were required for pulling out the plungers, it was no longer possible for the girls to have their fingers in the danger zone when the ram was depressed. As presses of this type are very common in shops doing a variety of light work, the scheme described may prove of service to others.

J. SYSMORE

COMBINATION FOLDING AND CURLING DIE

The accompanying illustration Fig. 3 shows a combination folding and curling die used for making the rectangular box shown in Fig. 1, which is produced from 80- to 90-pound tin.

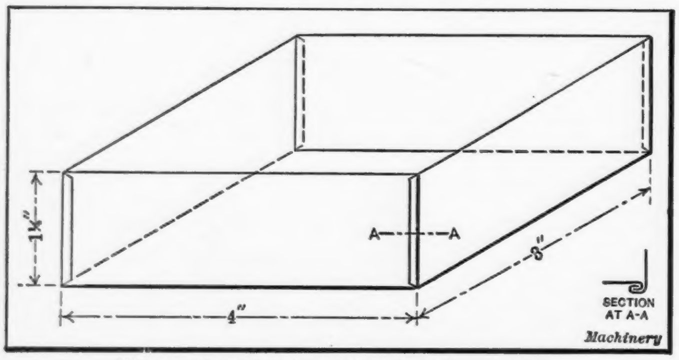


Fig. 1. The Box to be made and Section of Seam

At *A-A* is shown the section of the joint produced at the corners of the box. These corners are curled over nicely while passing through the die. The blank indicated by the lines *B* in Fig. 3 is located against the stop-pins *S* and is folded around a rectangular punch. As this punch descends the stock at the corners is slightly drawn and then follows through the narrow slit in the first section *E* of the die to the conical groove in the second section *F* where it is curled. The curled part is then flattened out in the lower section *G* of the die. The box is completed in one stroke of the die, the joints being made powder-tight. No additional trimming is required. The die can be made of machine steel with the exception of the curling blocks *D*, also shown in Fig. 2, which should be made of tool steel, hardened, and then inserted into the middle section of the die. Four curling blocks are required, two "rights" and two "lefts," of course. The blanks were cut in a previous operation, as it was more convenient than to use a large and cumbersome progressive action die.

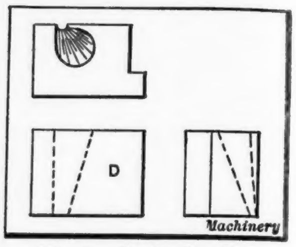


Fig. 2. The Curling Die

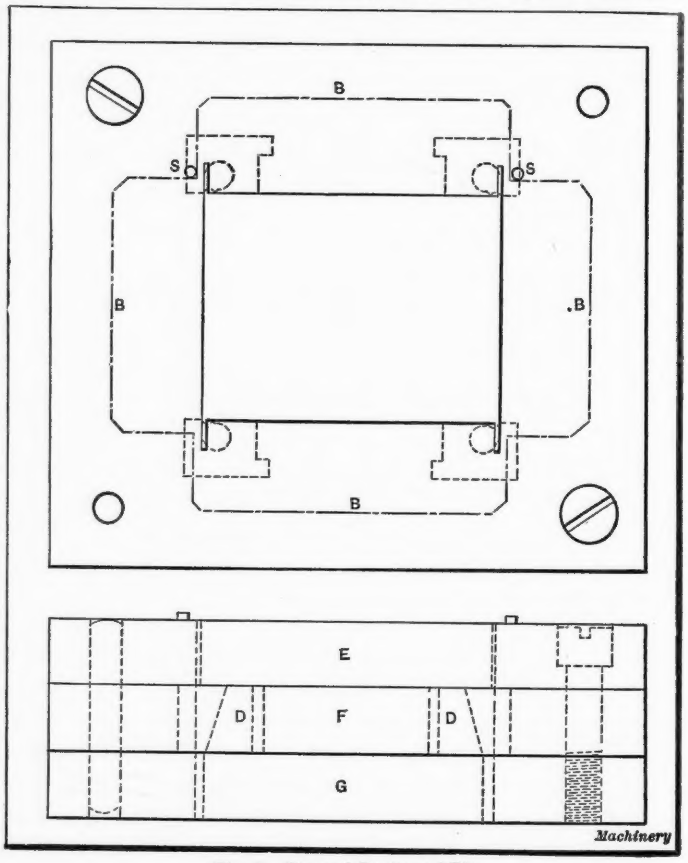


Fig. 3. General Design of Die

Columbus, Ohio. OTTO R. WINTER

CORRECT METHOD OF HANGING BLUEPRINTS AFTER WASHING

The writer has noticed that in most cases when blueprints have been washed, they are hung up so that they are as nearly level at the lower edge as possible. This method is not a good one, because when a print is hung so that the lower edge is practically level, the water will gravitate to this edge and hang there in globules, and the print will not be perfectly dry at this edge for hours; and in almost every case the edge is discolored.

The best way to hang blueprints for drying is to place them so that the lower edge is at an oblique angle with the horizontal; then the water will gravitate to the lowest corner. There will be no accumulation of water at other points, and the drying will be far more rapid than in the case when the sheet is hung level. This is a very small detail of drafting-room work, but it is of considerable consequence, both as regards time and the appearance of the blueprints.

St. Louis, Mo. C. H. CASEBOLT

* * *

A gib key should not be used to fasten a coupling on a shaft. If a key is used, it should be a headless key, or, still better, a feather.

ADVANTAGES OF A N. M. T. B. A. MECHANICAL SECTION*

In order to state clearly how the National Machine Tool Builders' Association could be benefited by the formation of a mechanical section, it will be necessary to review briefly the history of the industry with relation to the forces that have been active in bringing it from obscure job shop methods, both as regards manufacturing aand selling, to the proud position of one of the largest manufacturing industries in the land. Judging from the number and character of machine tools of foreign make purchased prior to 1875, and still in use in some railway division shops, the machine tool industry of those days must certainly have been in its infancy. There are men still active or recently passed away who have been in touch with the industry during all the years since then, and who are responsible for the marvelous changes that have taken place. The story of their lives is the story of the development of the industry. Few of these men were distinguished as salesmen. Financiering and accounting in the modern sense were unknown to them, but they were able mechanics—master workmen of their day, possessed of almost egotistical pride in personal accomplishments in their line. Guarding jealously the product of their own brain, they for the most part respected the rights of competitors, whether registered in the patent office or not.

These men had their faults, it is true, growing out of conditions then existing. They traveled little, they never met their competitors face to face, and knew nothing of them except through their dealer, who visited the shops occasionally to place stock orders for the requirements of the next six months or year. It is, therefore, little wonder that a competitor was regarded as an enemy, incompetent and unscrupulous. These were the golden days for the dealer. Factory sales organizations were unknown, and selling costs were at a minimum. The manufacturer knew nothing of shop costs, and sale prices were made to harmonize with the sale prices of competitors, with the result that profits to those engaged in the industry were small in almost any line requiring high-grade effort.

Out of these conditions, bad as they were with relation to the commercial end of the business, came a mighty strength, for as early as 1893 all the nations of Europe had discovered that this country was producing metal working machinery superior to that which could be found elsewhere. Was it superior sales organizations that gave us almost exclusive control of this great market for the next ten years and established a reputation for American tools that still lingers in spite of later developments abroad?

As proof of this statement, it may be well to cite an incident touching this point. The author was present at an interview in the factory office between one of these peerless pioneer mechanics and a European purchasing agent, who was regarded as a joke, and whose proposal to sell quantities of the manufacturer's product abroad was almost turned down. This mechanical man simply could not understand why any one would wish to come all the way from Europe to purchase the product of his little shop. He was inclined to regard his visitor with suspicion.

Since that day the tremendous increase in the demand for metal working machinery both at home and abroad has been working a transformation in the management and ownership of the business. That this transformation is natural, logical, and inevitable, the author shall not attempt to dispute; but it carries with it dangers that must be guarded against. We must occasionally get back to first principles and not lose sight of the reason why Europeans first came to extensively purchase the product of our shops, with practically no solicitation. The familiar title, the old man or the boss, the master workman of yore, who worked at the drawing-board, bench, or desk, is now transformed to the title of "president" or "general manager", and his knowledge of shop conditions is gathered from a condensed record of costs prepared by an expert in his line, all of which is well and necessary, but which marks a distinct change in the relative importance of the commercial and mechanical departments.

Since the organization of the Machine Tool Builders' Association there has been a noticeable improvement in many directions, and all honor to those leaders who have been its promoters and ardent supporters. Competitors now meet on a basis of real friendship; but something has been lost in the passing of the old professional spirit and pride with reference to mechanical things that will ultimately work great injury. This mechanical spirit that once dominated all, is now dominated by the commercial end. And while the author does not expect that the mechanical end can ever be reinstated in its old position of supreme importance, when coping with a sales organization that reaches around the world, we must not lose sight of the fact that in order to be successful in the markets of the world we must be able to offer at all times the best and the most advanced design to be found anywhere. If this can, in a measure, be brought about, great benefit may come to the Machine Tool Builders' Association by the formation of a mechanical section.

It is more difficult in these days when all-around skilled help is at a premium, for the superintendent and foreman to get away from their work, than for any other set of men connected with the plant. However, this does not apply with the same force to men connected with the designing end of the business. Our trade papers are alert to secure and publish anything of general interest to shop men and designers, and nearly all connected with the industry depend largely on these papers for their information, but, of course, there are lacking the benefits that would come from the personal touch.

It would seem that the annual convention could be extended over five or six days, with the last two or three days given up entirely to subjects that would be of general interest and benefit to the builders and designers of machine tools; or in place of the longer session, a three days' session with meetings held by the different departments in separate rooms, would, perhaps, be preferable.

Another subject for discussion is the advisability of holding in New York, by the National Machine Tool Builders' Association, at stated intervals of five or more years, an exhibition of metal working machinery, restricting each exhibitor to one machine of a type, and permitting no machine to be exhibited that did not show noteworthy improvement over the machine shown by the same exhibitor at the previous exhibition. While this thing may not be practical, the author is convinced that if it could be worked successfully, it would not only be a stimulus in the design of new machines, but would be of great value to the sales end of the business, as it would be sure to be attended by buyers of machinery from all parts of the world.

The whole thought is this: We must first have machines, and then salesmen to introduce them, if we are to maintain ourselves in the foreign markets, as well as in the home markets, for our experience during the past year shows clearly whither we are tending as regards protection. Let us develop the highest grade of commercial spirit, and use if possible this same instrumentality to better our product, to the end that in a measure the professional mechanical spirit of yore be re-established, so that our foreign competitor, should he ever find his passage through the customs house unobstructed, will be greeted everywhere with the sign of the uplifted hand.

* Abstract of paper by E. J. Kearney, of the Kearney & Trecker Co., Milwaukee, Wis., read before the convention of the National Machine Tool Builders' Association, in New York City, October 17, 1912.

* * *

In a paper read before the Iron and Steel Institute, Great Britain, Mr. C. Chappell gave some interesting information relating to the influence of carbon on the corrodibility of iron. He stated that in rolled and annealed steels the corrodibility rises with the carbon content to a maximum at the saturation point (0.89 per cent carbon), and falls with a further increase of carbon. In hardened and tempered steel a continuous rise in corrodibility takes place with an increase of carbon up to a carbon content of 0.96 per cent. Quenching increases the corrodibility to a maximum, while annealing tends to reduce it to a minimum.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE MUELLER 18-INCH HEAVY-DUTY ENGINE LATHE

The Mueller Machine Tool Co., Cincinnati, O., has recently added to its line the 18-inch heavy-duty engine lathe illustrated in Fig. 1. This machine swings 18½ inches over the ways, 13¼ inches over the carriage, and takes work up to 2 feet 4½ inches between the centers.

The headstock is of massive construction and is ribbed and cross-ribbed to secure the maximum rigidity. The cone pulley has three steps of 9 1/4 inches, 11 3/16 inches and 13 5/32 inches diameter, and double belting 3 1/2 inches wide is used for driving, thus providing an abundance of power for the heaviest classes of service. The cone pulley is locked to or released from the face gear by a spring pull-pin.

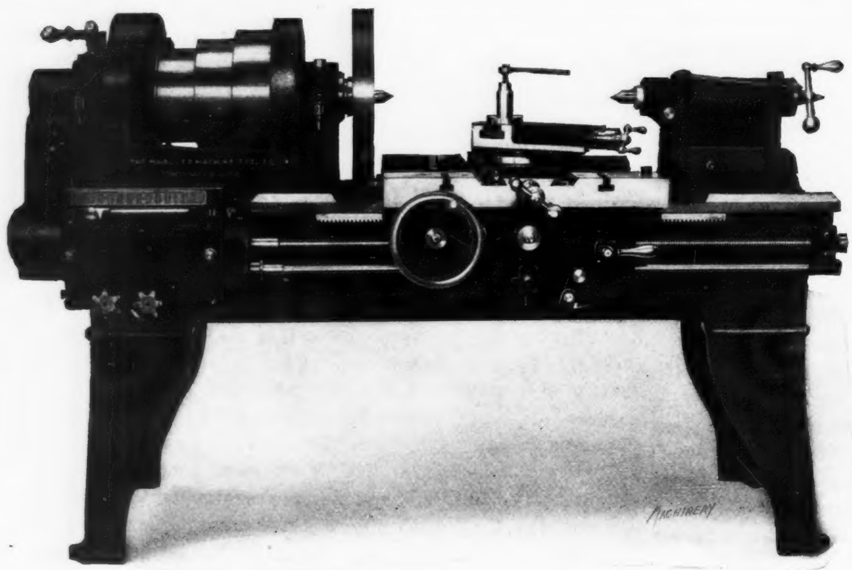


Fig. 1. The Mueller 18-inch Heavy-duty Engine Lathe

The tailstock is arranged with two plug clamps for locking the tailstock spindle without throwing it out of line. Both the headstock and tailstock are set off center, so that large diameters can be turned without having the bottom slide on the carriage overhang its bearings. The tailstock is clamped to the bed by means of two ¾-inch bolts; the tail spindle has a movement of 8¼ inches, and a bearing 2½ inches in diameter.

The work spindle is made of high-carbon crucible steel; it has a 1 9/16-inch hole through its entire length, and is fitted for a No. 4 Morse taper. The spindle boxes are of phosphor-bronze, bored and hand scraped to an accurate fit. The bearings are oiled through sight-feed oilers and felt pads which dip into a reservoir. The oil supplied to the bearings by this method is freed from all foreign matter, thus insuring perfect lubrication. The thrust collar is of hardened steel and the end motion is taken up by a nut at the end of the spindle. Nine spindle speeds are provided, ranging in geometrical progression from 13 to 300. The double back-gears on this machine are of the slip-gear type. A lever which is conveniently located at the front of the machine provides means for changing from low to high speed or *vice versa.* The back-gear ratios are 3½ to 1, and 10½ to 1.

This lathe will cut 45 thread pitches ranging from 2 to 60 per inch, including 11½ inch pipe thread. All changes are obtained within the quick change gear box. The ends of the shafts of the gear box and the reversing gears on the head are arranged to receive change-gears for special and metric thread cutting. All threads can be cut without the removal of a gear, and there is a chasing dial on the carriage for "catching" the threads. The turning feeds are positively geared, and are four times the thread feeds. They can be started, stopped or reversed in the apron or head, for either a cross or lateral feed motion, but only when the lead-screw nut is disengaged.

The carriage has exceptionally long bearings on the V's for its entire length. It has an adjustable taper gib the full length of its bearing against the rear side of the bed, thus eliminating the possibility of any twisting of the carriage while extra heavy cuts are being taken. A long shear wiper and oiler is fastened to each end of the carriage bearing on the shear; this arrangement automatically wipes the shear free from all dirt and chips, and oils it as the carriage moves along. The upper slide of the compound rest is bolted to the swivel base with four screws, which insures absolute rigidity.

The apron is of the rectangular box type, in which all the bearings for the gears and screws are cast integral with the apron itself. All gears are provided with bearings on both sides and the studs are of hardened and ground steel. The feeds are so arranged that only one feed can be in operation at a time. The lead-screw is 1 9/16 inch in diameter, and has a four pitch thread; it is only rotated when the lathe is engaged in screw cutting. The lead- and feed-screws for this lathe are cut from a master screw, thus insuring the greatest possible accuracy.

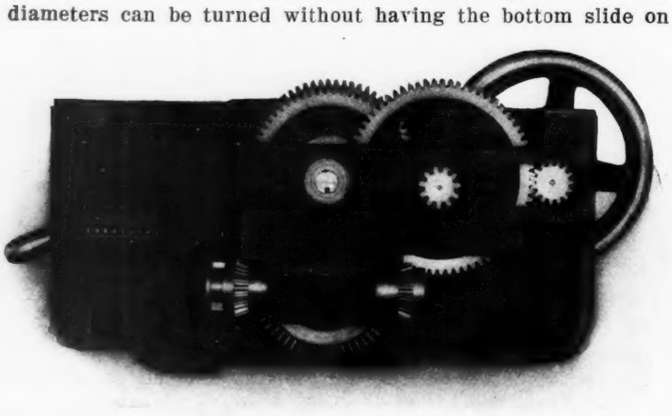


Fig. 2. Rear View of the Lathe Apron

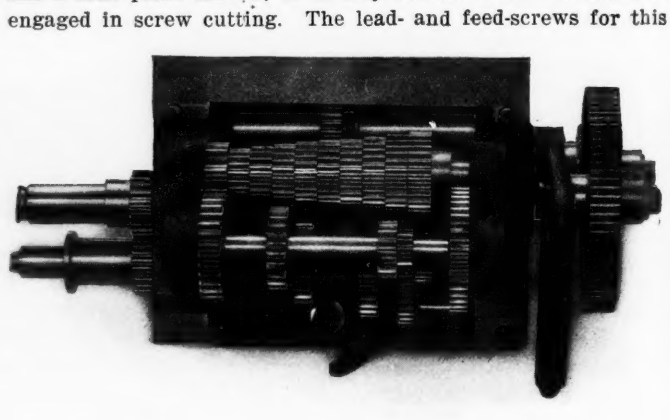


Fig. 3. Gear-box of the Mueller Lathe

The bed is designed with an unusual vertical depth and is firmly braced through its entire length with heavy cross girths, capable of absorbing the vibration of the heaviest cut. The rear bearing is flat. The countershaft has double friction pulleys, 14 inches in diameter. It is fitted with heavy bearings and hangers which insure rigidity and long life.

All gears in the quick change gear box are of steel and have chamfered teeth. Steel gears are also liberally distributed throughout the machine in all places where severe strains are encountered. The greatest care is taken in cutting all of

these gears in order to secure the maximum accuracy in the teeth and consequently smooth and noiseless operation. All gearing on the lathe is completely enclosed. The regular equipment consists of two faceplates for large and small stock, steady-rest, follow-rest, countershaft, and the necessary wrenches. The lathe can also be equipped with direct-connected motor drive and with a longer bed, when so required.

MILWAUKEE UPRIGHT DRILLING MACHINES

Two upright drilling machines built by the Richards Machine Co., 1129 Davis St., Milwaukee, Wis., are illustrated in Figs. 1 and 2. Fig. 1 shows the 20-inch machine equipped with back-gears, power feed and a combined wheel-and-lever feed. This machine can also be obtained without the back-gears and power feed, and with either a combined wheel-and-lever feed or a plain lever feed, as desired.

The chief feature of this machine is the method used in disengaging the power feed, when it is desired to use the wheel or lever feed. This device consists of an arm carrying the bevel gear, worm and worm shaft, which is operated by an eccentric for disengaging the bevel driving gears. In the illustration the lever for operating this eccentric is shown in the position it occupies when the power feed is being used. To disengage the power feed, this small lever is simply pulled towards the front of the machine.

There are eight changes of spindle speed and twenty-four changes of feed. The back-gears for the slow speed of the spindle are enclosed in the upper cone pulleys. Power for the automatic feed is obtained from the upper cone spindle, and

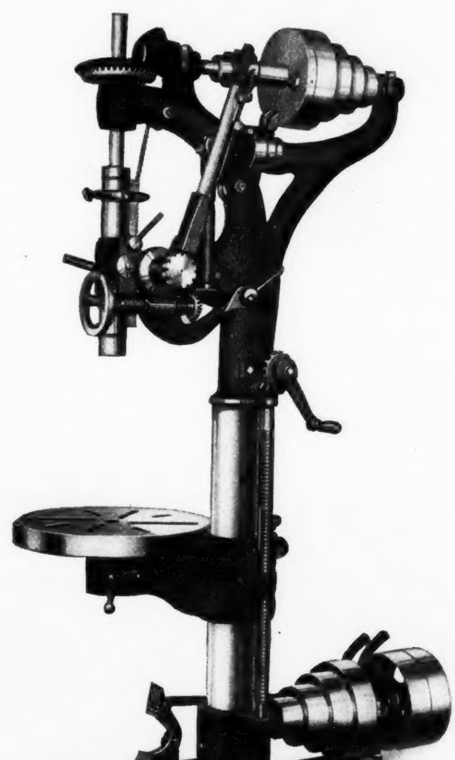


Fig. 1. Upright Drilling Machine built by Richards Machine Co.

is transmitted to the drill spindle by belt and the worm and bevel gearing shown.

The principal dimensions are as follows: Movement of drill spindle, 9 inches; greatest distance from end of spindle to base, 41 inches; greatest distance from end of spindle to table, 25 inches; height over-all, 69 inches; diameter of table, 17 inches; hole in spindle, No. 3 Morse taper. The machine will drill to the center of a 20-inch circle.

The upright drilling machine shown in Fig. 2 is provided with a sliding head, is back-geared, has positive feed and a number of interesting features not found in the other machine. Among these might be mentioned the gear-box for giving a positive feed to the spindle, and the device for effecting the feed changes. This device consists of two levers located directly below the gear-box, which operate a sliding gear for changing the rate of feed. These levers are properly located by a notched plate which they engage. By moving the lower lever up or down, three changes of feed are obtained, and by

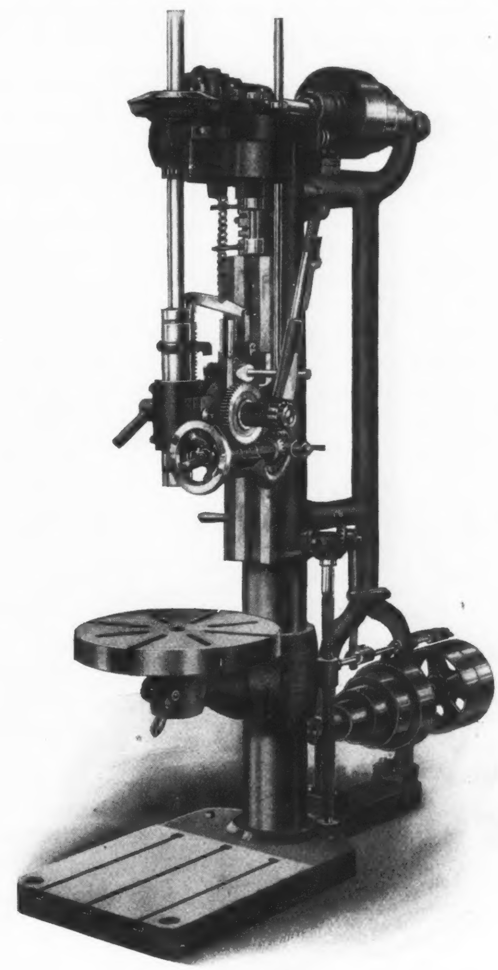


Fig. 2. Upright Drilling Machine of Sliding-head Type

shifting the upper lever into the "slow" or "fast" notch, six changes of feed are secured. With the top lever in the "slow" notch and the lower lever placed successively in the three notches, the feeds are: 0.003, 0.007 and 0.011 inch per revolution of the spindle. With the upper lever in the "fast" notch and the lower lever shifted to the three positions, the feeds are: 0.023, 0.060 and 0.095 inch per revolution of the spindle.

The back-gears are enclosed in the upper cone pulleys and are thus protected from dust and dirt. The principal dimensions of the machine shown in Fig. 2 are as follows: Movement of drill spindle, 10⅝ inches; movement of sliding head, 20 inches; greatest distance from spindle to base, 50 inches; least distance from spindle to base, 19 inches; greatest distance from table to spindle, 37 inches; diameter of table, 20 inches; height over-all, 84 inches; hole in spindle, No. 4 Morse taper; drilling capacity, to the center of a 24¾-inch circle. The weights of the machines shown in Figs. 1 and 2 are 600 and 1500 pounds, respectively.

CINCINNATI PRECISION LATHE WITH SCREW-CUTTING ATTACHMENT

The latest design of friction-driven bench lathe built by the Cincinnati Precision Lathe Co., Cincinnati, Ohio, is shown by the front and rear views, Figs. 1 and 2. This lathe has an improved friction drive and a slide-rest screw-cutting attachment. The difference between the friction-driving mechanism of this lathe and those formerly built is in the control and the construction of the driven disk. The latter,

instead of being a solid piece, is formed of two members which are separated by a series of coiled springs, thus forming a spring tension or "cushion" disk. These two parts are shown in detail in Fig. 3. In addition to springs, there are a number of steel guiding studs near the circumference of the disk and a large projecting hub in the center, all of which engage holes in the upper member. The guiding studs and hub are accurately fitted and there is also a bearing fit between the flange on the lower disk and the periphery of the upper disk, which insures a uniform tension at all points on the horizontal friction surface.

A further advantage claimed for this disk is that there is a very slight tendency of the horizontal friction plate to incline with relation to the driving shaft when the friction driving wheel is located outside of the center. This movement, while very slight, is just sufficient to release that part of the friction filler material which would otherwise bear against the outer and more rapidly moving surfaces on the driven disk. In this way the sliding action between the two surfaces, which is common to a rigid-disk friction drive, is obviated and the loss of friction material reduced. As the driving disk is applied on both sides of the driven disk center for obtaining forward and reverse speeds, the face or periphery of the driving disk wears uniformly or parallel to the friction driving shaft. As the driving disk approaches the center of the driven member, the spring tension increases slightly because the wheel comes directly under an increasing number of springs as it approaches the central and higher speed positions. In case a heavier spring tension is desired, the lower driving shaft can be raised by means of eccentric bushings provided.

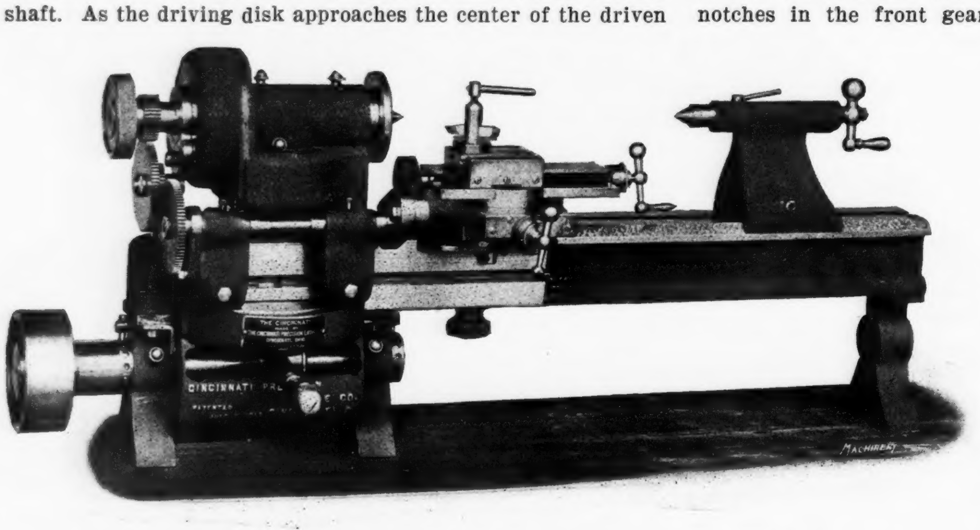


Fig. 1. Cincinnati Friction-driven Precision Lathe with Slide-rest Screw-cutting Attachment

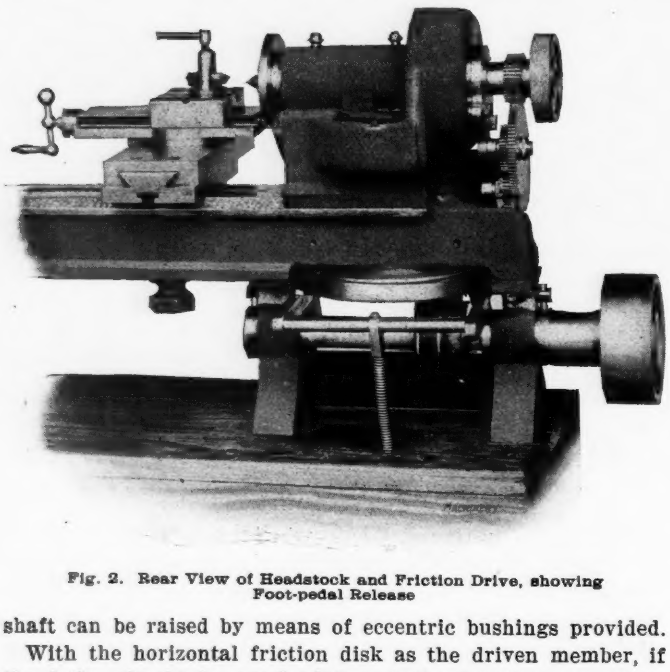


Fig. 2. Rear View of Headstock and Friction Drive, showing Foot-pedal Release

With the horizontal friction disk as the driven member, if the lathe should be overloaded and the frictions caused to slip, the driving disk would continue to revolve and the wear would be uniform instead of forming flat spots. It is claimed that the location of the driving pulley at the base and the use of the cushioned disk reduces vibration to a minimum. The friction hand-control lever for varying the speeds has a circular inner end which engages a recess or slot in the hub of the driving disk. The latter slides easily on the friction driving shaft and a longitudinal key inserted in the shaft, when the friction members are disengaged. The lower side of the control hand lever is so shaped as to readily drop into notches in the front gear cover, for retaining the friction driving wheel in any desired speed location on the driven disk.

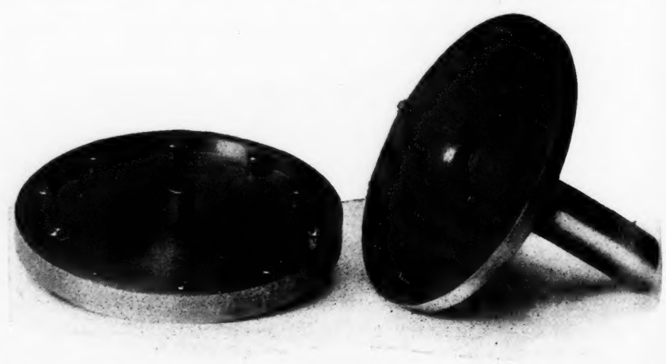


Fig. 3. The Two Parts of the Spring-tension or Cushion Friction Disk

The rear view of the lathe head and friction drive shown in Fig. 2 illustrates the foot pedal release that is applied to this lathe. This releasing mechanism consists of two arms or levers, on the ends of which are bushed fiber rollers so arranged that when pressure is applied to the foot pedal the friction disk surface is raised, thereby disengaging the friction driving member. At the same time, the rollers act as a brake and stop the machine almost instantly. The forward or reverse speed changes can be quickly made, and, as the spindle can be stopped and started very quickly, threads can be cut close to a shoulder with safety. The spring seen between the bench and lever cross-arm is for holding the lifting levers away from the disk when the lathe is in motion. The foot pedal is pushed under a retaining step on the floor when the lathe is to remain stationary.

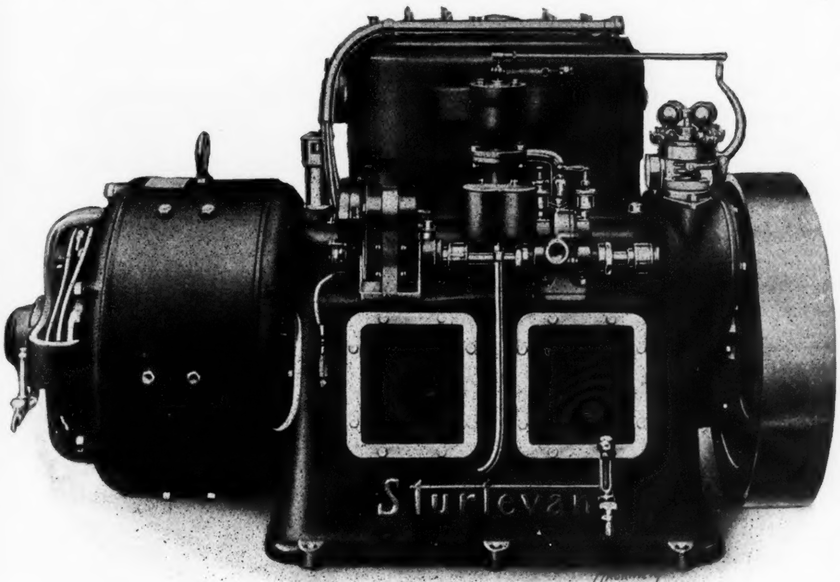
STURTEVANT GASOLINE-ELECTRIC GENERATING SETS

The B. F. Sturtevant Co., Hyde Park, Mass., is now building gasoline-electric generating sets designed to supply the demand for units that will be easy and inexpensive to operate, in places where electric power is not available. These sets are intended to be used in direct connection with lighting and power circuits and not through a storage battery, although they can be so arranged if desired. The design, workmanship and efficient governor control are said to insure constant voltage through wide variations of load, so that the use of a storage battery to equalize fluctuations of voltage is not necessary.

These generating sets are built in three sizes of five, ten and fifteen kilowatts capacity, capable of lighting 200, 400 or 600 twenty-candlepower tungsten lamps, respectively. The five-kilowatt size is illustrated herewith. These sets consist of a Sturtevant gasoline engine directly connected to a Sturtevant direct-current electric generator. The engine is of the four-cycle, water-cooled, vertical type, having either four or six cylinders, according to the size of the unit. The bore of the cylinders used in the ten and fifteen kilowatt sizes is 4 inches, and the stroke 6 inches, whereas the five-kilowatt engine has a 3¼-inch bore and a 5-inch stroke. The cylinders

of the two larger sizes are cast in pairs and have T-shaped heads with inlet valves on one side and exhaust valves on the other. The cylinders of the five-kilowatt engine are cast *en bloc* with inlet and exhaust valves on the same side. In both cases the water jackets are integral.

The cylinders are accurately bored and ground to size, and provision is made for the easy removal of the valves for inspection or regrinding. The pistons have four rings and the



Sturtevant Five-kilowatt Gasoline-electric Generating Set

piston pins are of large diameter and are made of hardened steel. Both the piston and pin are accurately ground and finished. The connecting-rods are exceptionally long, of I-section and are drop-forged from high-grade steel. The inlet and exhaust valves are of nickel steel. The valves for the ten and fifteen kilowatt units are operated by two camshafts, whereas one camshaft is used on the five-kilowatt size. The cams are integral with their shafts and are hardened and ground to the proper shape. The engine bases of the ten and fifteen kilowatt sets are made of two castings, split horizontally on the center line with the crankshaft bearings. A single casting is used for the base of the five-kilowatt unit and the generator is attached directly to the engine base, as the illustration shows. A separate sub-base for the engine and generator is provided on the larger sizes.

The crankshaft is made of 3½ per cent nickel steel which is of exceptionally high tensile strength and has undergone careful heat-treatment. All pins and journals are accurately ground. The most improved system of forced lubrication is used, the oil being furnished to all bearings under a pressure of 20 pounds, by means of a gear pump located in the engine base. The oil enters the main bearings and flows through the crankshaft (which is drilled for that purpose) to the crankpins, whence it passes up the connecting-rods to the piston pins. The oil spray thrown off by the centrifugal action of the crankshaft covers the piston and cylinder walls. When the oil falls back into the base it passes through a filter before being used again.

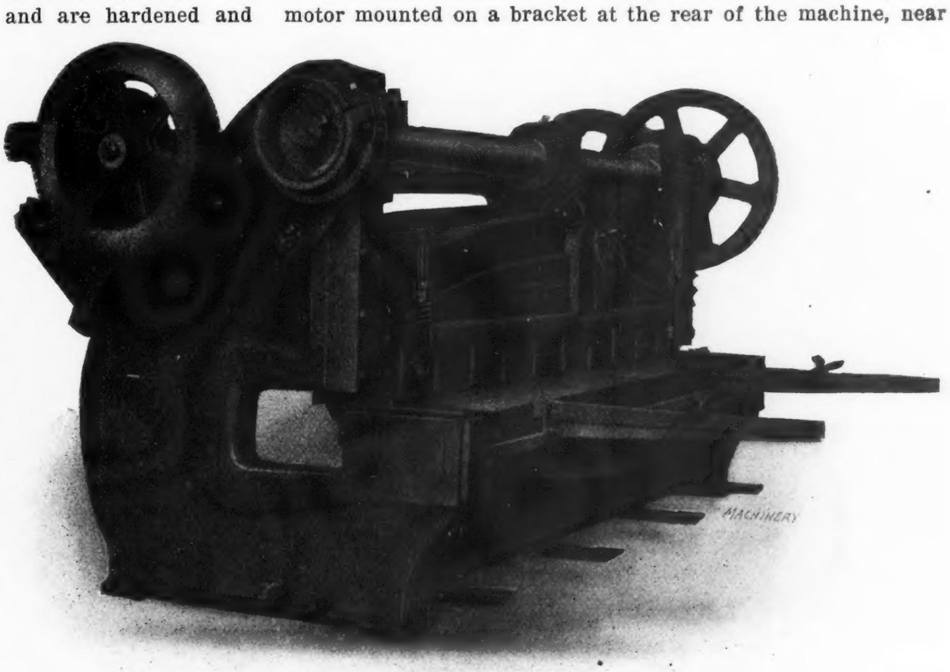
The engine is controlled by a throttling governor of the centrifugal type, operated through bevel gears from the end of the crankshaft. The motion of the governor is transmitted to a throttle valve placed in the inlet manifold. This governor is said to regulate the speed of the engine so accurately between no load and full load, that the voltage variations due to sudden changes in the load are imperceptible and no storage battery is necessary to maintain a constant voltage. The engine is equipped with a high-tension Bosch magneto, which is mounted on the base and is operated from the camshaft. The same type of generator that has been used in connection with Sturtevant steam engines of the U. S. Navy and merchant marine, is used for these gasoline power units. The generator is designed to require a minimum amount of attention. Both the engine and generator are capable of operating under an overload of 25 per cent for two hours.

NIAGARA MOTOR-DRIVEN PLATE SHEAR

A plate gap-shear recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y., is shown herewith. This machine has the convenient means for adjusting the bed, crosshead and gibs, common to all large shears built by this company. The motion is controlled by a positive clutch which can be operated by a foot treadle, and the machine stops automatically when the crosshead reaches the highest position. The "hold-down" is raised and lowered by two cams, keyed to opposite ends of the crankshaft. The latter is forged from high-carbon steel.

The arrangement for adjusting the back gage attached to the cutter-bar is a new feature. This gage can be quickly adjusted by the operator, when he stands in front of the machine, by means of the handwheel seen in the center of the shear. The motion is transmitted to the gage by shafting, bevel gears and feed-screws at the rear. The gage always remains in a position parallel to the knives.

This shear is driven by a direct-connected, 15-horsepower motor mounted on a bracket at the rear of the machine, near



Niagara Motor-driven Plate Shear

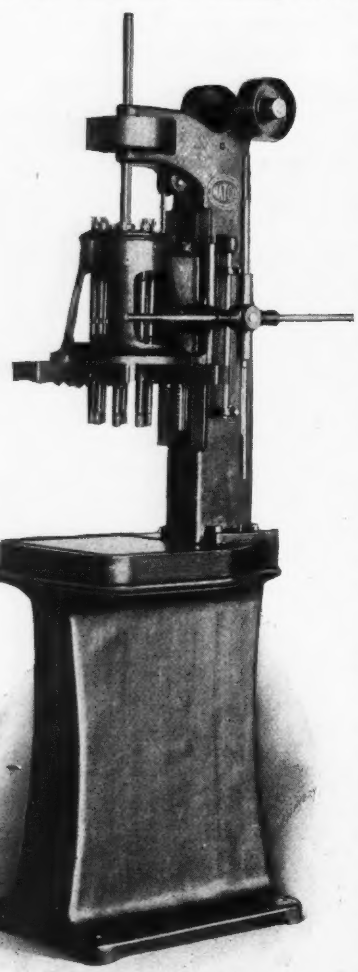
the gearing seen to the extreme left in the illustration. It has a cutting length of 126 inches and will cut soft steel up to ¼ inch thick. The weight of the shear is about 22,000 pounds.

THE NATCO NO. 9 MULTIPLE DRILLER

The National Automatic Tool Co., Richmond, Ind., has added to its line of multiple drillers, a smaller machine which in-

cludes a number of new features in its design. This machine is known as the Natco No. 9, Type D, and has been designed with a view of replacing multiple spindle drill fixtures which are not only entirely special, but which require a large drilling machine to drive them. This machine can be arranged for either bench or floor use, as it is made with a separate base upon which the machine is mounted for service as a floor drill. The illustration shows the machine set up in this manner, while for use on a bench, it would, of course, be taken from the base.

The method of indépendently changing the spindle speeds in use on the other multiple drillers made by this company is not used on the present machine, as the maximum size of drills for which it is intended is ¼ inch. The head feeds down to the work by means of a capstan operating a rack and pinion; the head has a bearing 11½ inches in width and a maximum travel of 12 inches. It is counterbalanced by means of a chain and weight, and is provided with adjustable stops for drilling holes to a specified depth. Adjustable gibs provide means to take up any wear that may develop, and the machine has a maximum capacity for a circle 8⅜ inches in diameter.



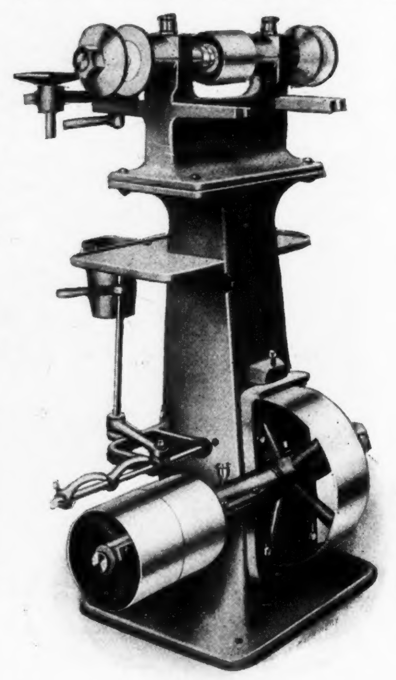
The National Automatic Tool Co.'s No. 9 Multiple Drilling Machine

The same rail and joint construction is used on this machine as on the larger sizes of multiple drillers built by this company. The rails are made of steel and have a bearing of 4 inches for the spindle. They are provided with ball thrust bearings, means of adjusting for wear and ample oiling facilities. Two sizes of rails are used which are known as the No. 1 and No. 2 size. The largest drill for the No. 1 size is 3/16 inch, with minimum centers 21/32 inch; for the No. 2 rail, the largest drill used is 1/4 inch, with minimum centers 25/32. If closer centers are desired, special rails can be furnished. The rails are easily changed from one layout to another. The base has a working surface 14½ inches square, and the surface over the oil groove is 17¼ by 18¼ inches. The maximum distance from the end of the spindle to the base is 15 inches, and the minimum distance 3 inches.

This machine can also be equipped with cluster boxes in which all of the spindles are permanently located. With a cluster box equipment, it is possible to drill a larger number of holes than with the rails, the number depending upon the material to be drilled and the size of the holes. The use of these cluster boxes saves the time occupied in changing rails from one layout to another and any number of cluster boxes can be used on a given machine, as all boxes are made interchangeable. The advantages of the cluster boxes for strictly interchangeable manufacturing are apparent. The illustration shows the machine equipped for belt drive, but individual motor drive can be furnished if so desired.

ST. LOUIS GRINDER

The grinder shown in the illustration is an improved design now being built by the St. Louis Machine Tool Co., 1209 Gratiot St., St. Louis, Mo. The countershaft of this grinder is carried by a frame that is attached to the column by accurately milled square gibs. With this construction, the countershaft is kept in accurate alignment and the tension of the belt can easily be varied by simply raising or lowering the frame, a suitable adjusting screw being provided for that purpose. By driving the spindle from below, the wheels run smoothly, as the pull of the belt is downward against the rigid body of the machine.

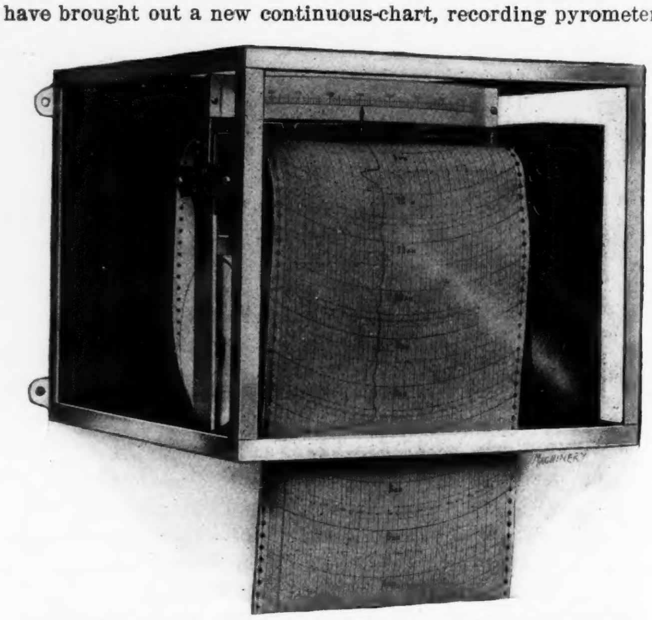


Rear View of St Louis Grinder showing Method of Attaching Countershaft

The spindle of this grinder is made of 0.40 per cent carbon steel. The boxes are dustproof and the rests are of an improved design requiring a shorter bracket than the straight type. As the illustration shows, the machine is also equipped with backrests for attaching wheel guards or fixtures. The wheel guard is a simple and effective design consisting of a steel channel rolled to a segment of a circle and reinforced by a heavy cast-iron bracket riveted to the inside flange. This bracket is attached to the back-rest by a bolt which slides in the slot, thus allowing the guard to be adjusted backward as the wheel wears. The lips of the guard can be kept close to the wheel where they are not in the operator's way. These grinders are made in six sizes.

CONTINUOUS-CHART RECORDING PYROMETER

The Brown Instrument Co., of Philadelphia, Pa., and its associate company, the Keystone Electrical Instrument Co., have brought out a new continuous-chart, recording pyrometer.



Continuous-chart Recording Instrument for Indicating Temperatures, Volts, Amperes, etc.

This instrument is designed more particularly for use as a pyrometer, but can also be employed for indicating volts, amperes, revolutions per minute, mechanical operations, etc.,

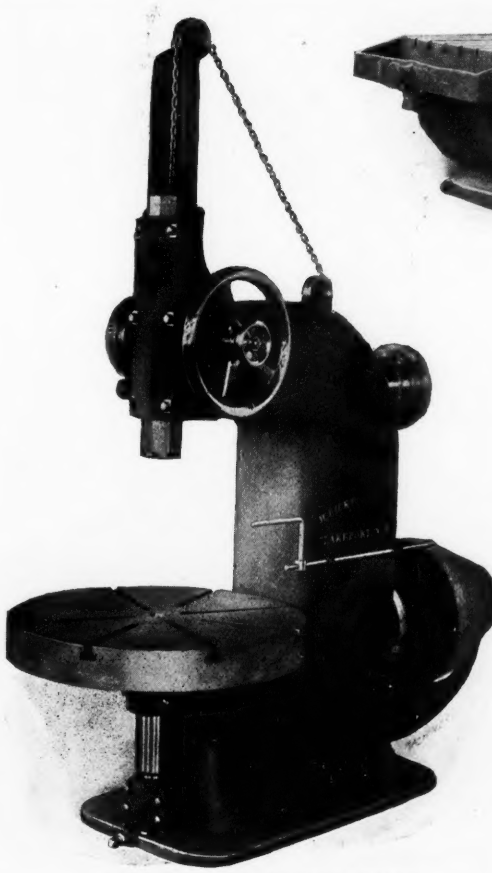
where a small current of electricity is required to operate a recording instrument.

The construction of this instrument is simple, and the works are enclosed in a plate-glass case. It is of the frictionless type, the pen forming a line by making single dots of ink on the paper at short intervals of ten seconds or a minute, as desired. These dots practically form a continuous line. The instrument carries a roll of recording paper which will last six months. This paper travels a little over an inch an hour, so that it is not necessary to change the charts daily and a continuous record can be secured.

BICKFORD VERTICAL CHUCKING MACHINE

The vertical chucking machine shown in the accompanying engraving has been designed to supply the demand for a low-priced tool for boring car wheels, gears, pulleys, and similar work. The tool-slide of this machine is octagonal in shape and is counterbalanced. The spindle feed is operated through a large friction worm-gear on the left side of the head, which runs in oil. This worm-gear is driven through a geared feed-shaft connecting with the main driving shaft by the four-step feed cones seen at the rear, which gives four changes of feed. A large handwheel is provided for hand adjustment and a quick-return movement, and the friction feed is engaged by means of a small handwheel in the center of the large wheel.

The table is driven through heavy bevel gears and it has a large spindle fitted with adjustable boxes. The weight of the table and work is taken by a hardened and ground steel step



Bickford Vertical Chucking Machine

which is submerged in oil and is adjustable. The frame of the machine is very rigid. The driving shaft is mounted in three long bearings and the outer end is supported by a heavy arm attached to the frame. This machine can be equipped with detachable chuck jaws or a special chuck table. The swing is 37 inches, and the total movement of the spindle, 29⅛ inches. It is built by H. Bickford & Co., Lakeport, N. H.

INGERSOLL MILLING MACHINE

The Ingersoll Milling Machine Co., Rockford, Ill., recently installed the large five-head, six-spindle horizontal milling machine shown in Fig. 1, in one of the largest tractor plants in this country. This machine is used for milling forty and sixty horsepower tractor engine frames, as indicated in Fig. 2. These frames are finished complete on this machine and five cutters operate simultaneously. The largest of these cutters has a diameter of 36 inches.

The bed and table of the machine are of the conventional planer-type construction, and the wings upon which the housings are mounted are cast integral with the bed. The housings and cross-rail are also made in one piece, and because of this feature, the machine is known as the "fixed rail" type. The casting forming the housings and cross-rail, is very large and heavy, as the illustration indicates. The face or bearing for the saddles is 21 inches wide and the housings are 36 inches deep. The distance from the top of the table to the under side of the rail is 42 inches.

As previously mentioned, the machine has five heads, three of which are horizontal and two vertical. One of the horizon-

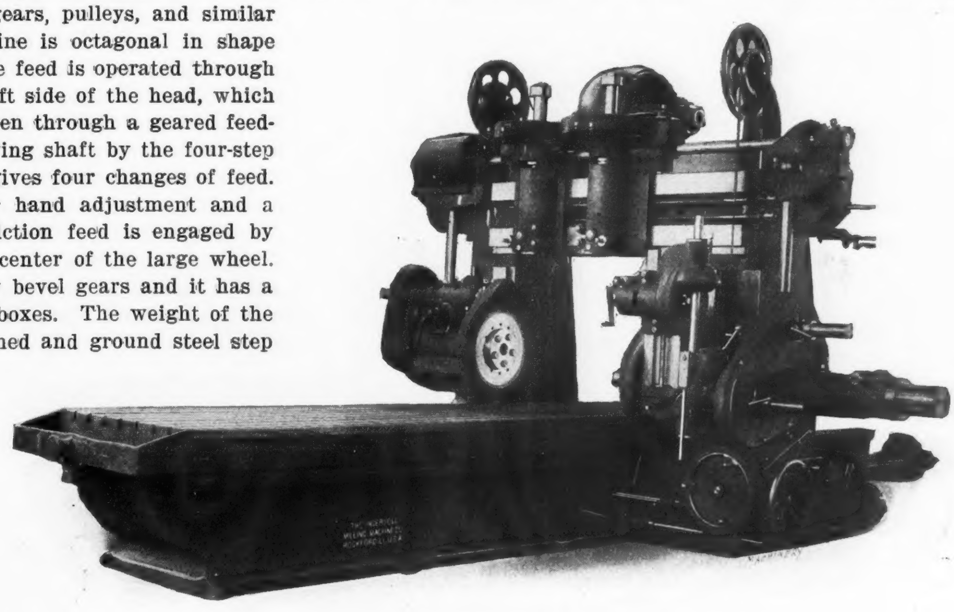


Fig. 1. Ingersoll Five-head, Six-spindle Milling Machine

tal heads is mounted on the left-hand housing, and on the right-hand side there is a main head carrying an auxiliary head and also an extra spindle which passes through the main spindle. The horizontal heads on both sides are counterbalanced and can be moved simultaneously or independently.

The right-hand horizontal head is the most massive, as the illustration shows. Its main spindle is of the faceplate-drive type and is arranged to carry cutters varying from 24 to 36 inches in diameter. The spindle which passes through this

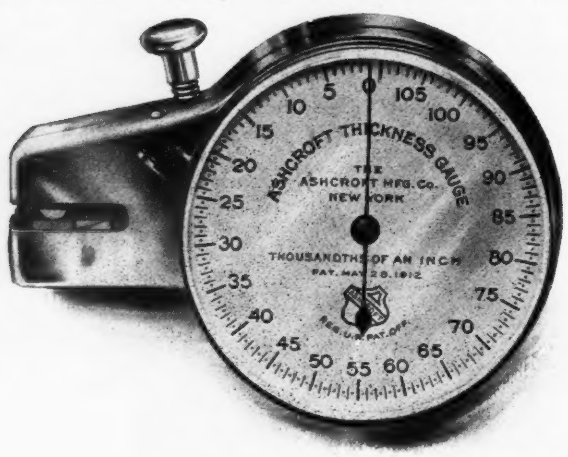
Fig. 2. Ingersoll Machine Milling Tractor Engine Frames

main spindle, is used for driving small cutters. It is 4½ inches in diameter and has an in-and-out adjustment of 18 inches. The auxiliary head or saddle is in front of the main spindle and also has a 4½-inch spindle which runs in a sleeve or quill 6⅛ inches in diameter. The spindle has an in-and-out hand adjustment of 6 inches, and the saddle itself has a vertical adjustment of 18 inches on the main saddle.

The left-hand horizontal head is also of the faceplate-drive type, cutters of large diameter being bolted directly to the spindle driving gear. The vertical spindles are 4½ inches in diameter. The drive is a 40 H. P. direct-connected motor.

ASHCROFT THICKNESS GAGE FOR SHEET MATERIALS

The Ashcroft thickness gage shown in the illustration is a convenient and accurate instrument for quickly measuring the thickness of sheet metal, sheet rubber, leather, paper, box-board or any sheet material not exceeding 0.110 inch in thickness. It is of a convenient size to be held in the hands, and the material to be measured is inserted between the jaws which are opened by pressing a push-button with the finger.



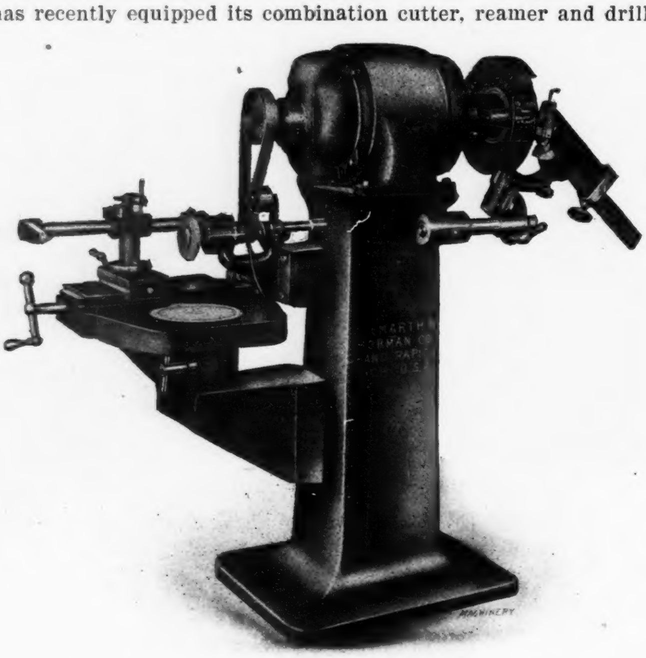
Ashcroft Thickness Gage for Sheet Materials

When pressure on the push-button is released, the jaws automatically close and the thickness of the material is indicated on the dial.

The white enamelled dial is easy to read, as the graduations stand out distinctly. The dashes represent thousandths, the dots one-half thousandths, and the points equidistant between the dots and dashes, one-quarter thousandths of an inch. The gage has no sliding parts, the movement being mounted on steel pivots. Friction and wear are thus reduced to a minimum. This gage can be carried in the vest pocket, if desired, and, with proper care, will last for years. It has been placed on the market by the Ashcroft Mfg. Co., 85 Liberty St., New York. The price of the instrument is $10.

WILMARTH & MORMAN MOTOR-DRIVEN CUTTER, REAMER AND DRILL GRINDER

Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has recently equipped its combination cutter, reamer and drill



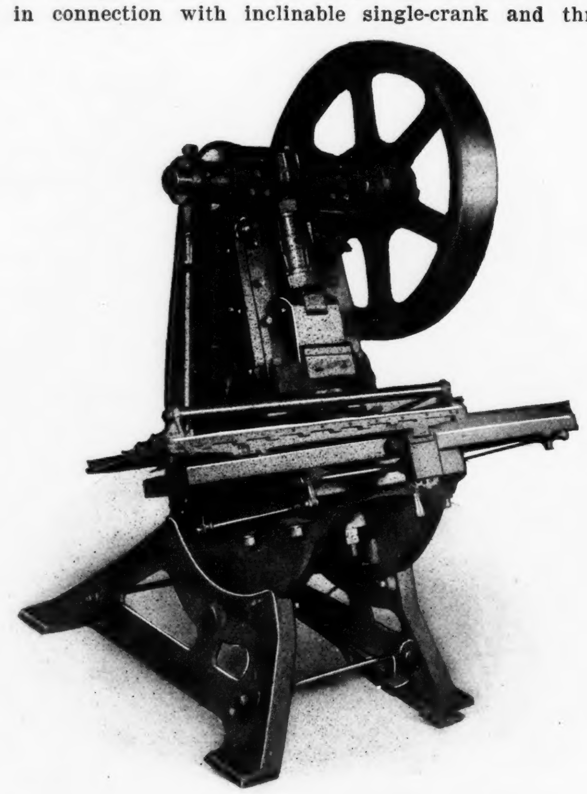
Wilmarth & Morman Motor-driven Combination Cutter, Reamer and Drill Grinder

grinder with a direct connected motor drive. The motor on this machine is one horsepower, and is made by the General Electric Co. to meet the special requirements of the present class of work. The controller for the motor is mounted on the column of the machine, and the power switch is located directly beneath the controller. The table and its slide are mounted on a knee, as shown in the illustration, so that it is possible to swivel the table around to enable grinding to be done on either side of a plain wheel, or to provide for the use of a cup-wheel.

The machine will grind face and side milling cutters up to 12 inches in diameter, straight or taper reamers up to 17 inches in length with flutes not over 11½ inches, angle milling cutters of any angle up to 8 inches, plain milling cutters of any type up to 8 inches, gear cutters up to 5½ inches, hobs up to 5½ inches, forming cutters of any length up to 5½ inches in diameter, and flutes of taps up to 11½ inches in length. The machine will take cylindrical or taper work up to 7¼ inches in diameter and 11½ inches in length. It has a maximum distance between centers of 17 inches, and a capacity for internal grinding up to 4 inches in depth by 10½ inch swing. The drill grinding attachment is the regular new Yankee non-calipering type, which provides for simply dropping the drill in the holder and grinding it. The capacity for drill grinding runs from No. 60 to ⅝ inch, from 3/32 to 1¼ inch, or from ⅛ inch to 2¼ inches.

STAGGER FEED SPACING TABLE FOR BLISS PRESSES

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently developed and patented a stagger-feed spacing table for use in connection with inclinable single-crank and three-



Bliss Inclinable Press equipped with Stagger-feed Spacing Table

crank, double-action presses. This attachment is adapted for rapid, accurate feeding of decorated stock for bottle caps, covers, and similar work.

The table is moved by the operator after each stroke of the press and is locked by a cam-actuated stop which engages a rack on the table. The table is a light aluminum casting mounted on rollers. This construction allows the operator to cut an entire row of blanks without stopping the press. A handle bar is provided which is used to move the table and also, through eccentric pivots, to control the grippers. The sheet is first placed between the guides on the table and rests on a pair of preliminary stops which locate it for cutting the first row. A twist of the handle bar then closes the grippers, the preliminary stops are lifted clear by a knob at the right and the first row is cut. Subsequent rows are gaged by al-

lowing the sheet to drop against a straightedge at the back. All the operator has to do is to open the grippers, allow the sheet to fall, and close the grippers again.

A pair of scrap cutting dies is used to trim the sheet so that new gage points are made as each row is cut. The scrap is cut into small pieces, and scrap cutters are usually mounted on the same block as the die, to facilitate setting. The table is designed to handle standard sheets 20 inches wide by 28 inches long, and adjustment is provided to take sheets up to 30 inches long. The spacing rack for gaging is clamped over a T-slot and can be removed readily and different spacing racks attached. The speed of the press can range from 120 to 150 strokes per minute, depending on the size and character of the work.

THE CINCINNATI 36-INCH FROG AND SWITCH PLANER

The Cincinnati Planer Co., Cincinnati, O., has recently added to its line the 36-inch frog and switch planer illustrated in Figs. 1, 2 and 3. This machine has been constructed along lines which give it ample strength and rigidity for the heaviest classes of work. The bed is of the modern deep pattern, braced throughout by box girders, and is made with four

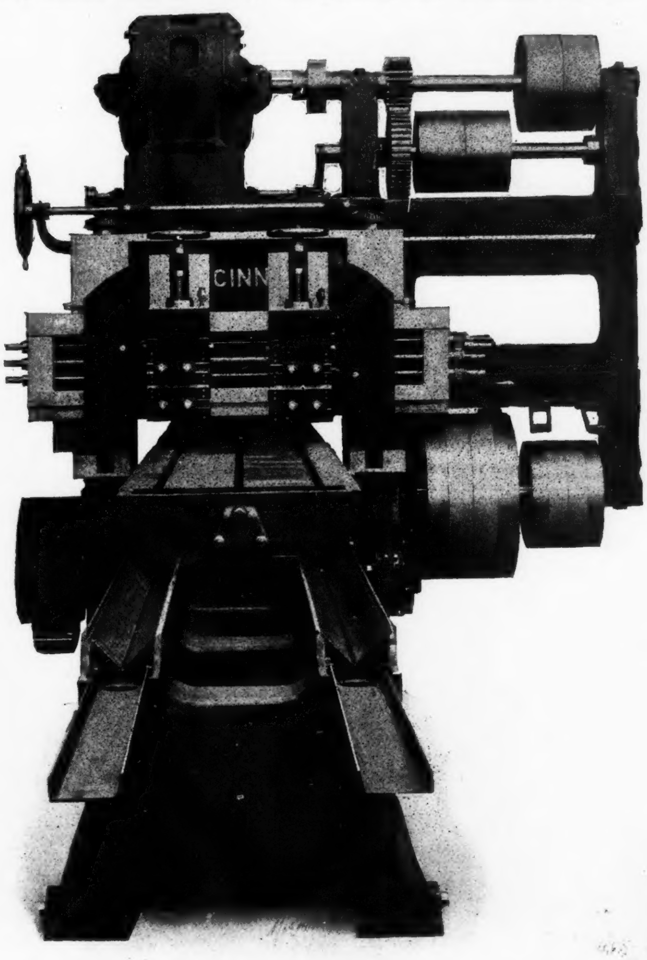


Fig. 1. Front View of Cincinnati 36-inch Frog and Switch Planer

walls between the housings where the greatest strain is developed. The vees are extra wide and are oiled by a forced lubrication system which maintains a film of oil between the table and bed at all times. The table is 32 inches in width, and has an inside bearing on the bed for its entire length, thus overcoming the pressure of heavy side cuts. Adjustable side gibs are provided on each side to prevent the table from lifting. The housings, which are of box form, have a 10-inch face and extend down to the floor. They are secured to the bed by bolts and dowel pins, and a tongue and groove 1½ inch deep by 5 inches wide. The cross-rail is 20 inches wide and has a deep ribbed box brace on the back to provide increased stiffness. In addition to the usual outside set of clamps, it is secured to the housings by an extra set of clamps on the inside; this design provides a very rigid form of construction. If desired, the cross-rail can be fastened to the housings by large dowel pins at various fixed heights. The rail screw has two long nuts in the saddle, thus reducing the strain on the threads when taking heavy side cuts and also insuring long life for both the screw and nut. The heads have automatic cross and vertical feeds, and are made right and

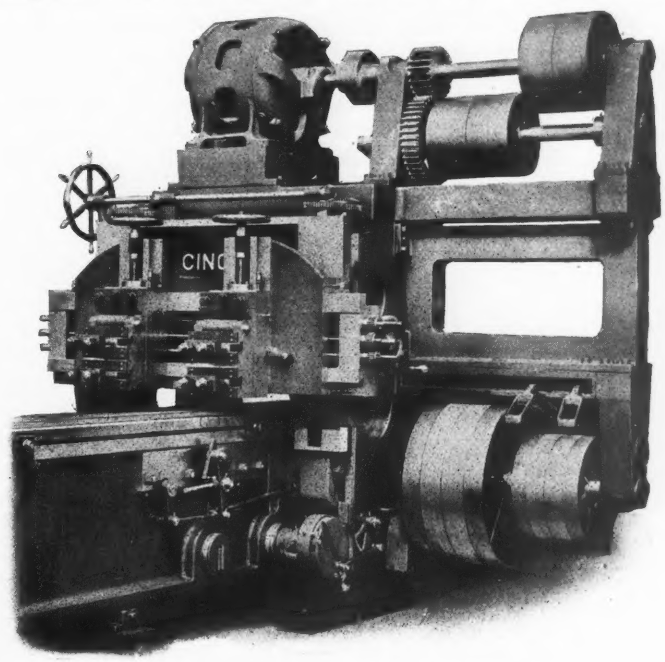


Fig. 2. Operating Side of Cincinnati Planer

left to bring them close together. The saddle and harp are made in one piece, without a swivel, and have a bearing of 25 inches on the rail. The countershaft is mounted on top of the housings and is driven by a 50 H. P. motor as shown, thus making the machine self-contained. A heavy cast-iron frame is fitted between the upper and lower bearings, and is

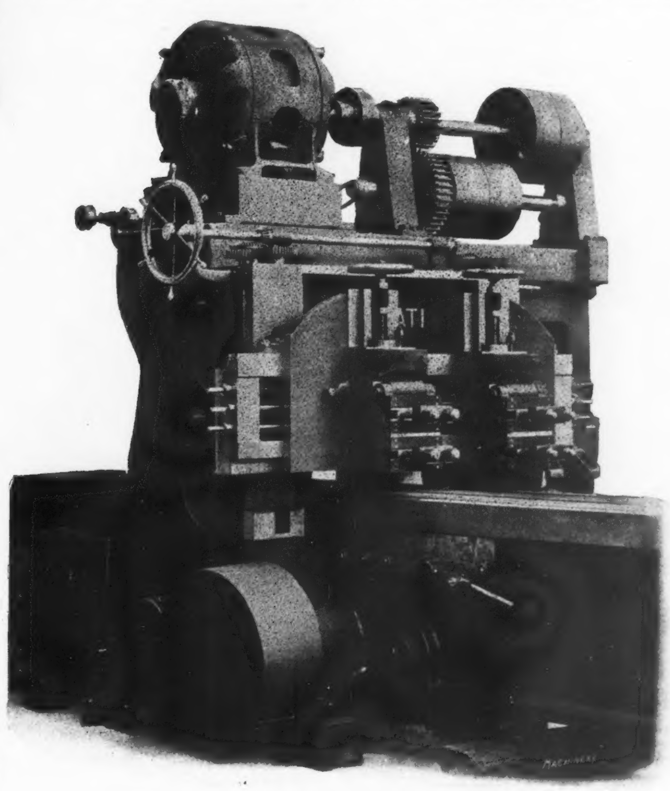


Fig. 3. Another View of Frog and Switch Planer

also fastened to the housings so that there can be no spring in the shafts or bearings when the machine is working on the heaviest cuts. The driving pulleys are 34 inches in diameter and are made of aluminum alloy, thus providing for a quick reverse on short strokes. The four-belt drive used on this planer provides ample power for the heaviest classes of work, and the shifting mechanism is provided with a safety locking de-

vice which prevents the table from starting, except at the will of the operator. Levers are so arranged that the machine can be operated from either side. The driving shafts are of unusually large diameter; they are made of special crucible steel. They are accurately ground and run in long bearings which are fitted solidly into the bed. The driving pulleys are so constructed that they only require oiling once in sixty days. The rack and gearing are made of solid crucible steel, to enable them to withstand heavy strains incident to frog and switch work; the bull wheel and rack are 12 inches in width and 1½ diametral pitch.

BLAKE & JOHNSON GANG SLITTING MACHINE

The Blake & Johnson Co., Waterbury, Conn., has brought out an improved gang slitter for cutting steel or other metals into strips. This machine, which is illustrated in Figs. 1 and 2, is so designed that the cutters can be changed in a minimum of time. The upper arbor is hinged on an intermediate shaft and is adjustable to or from the lower arbor, on an arc rather than a straight line. As the driven gear on the upper arbor revolves about the center of the driving gear, both gears remain in mesh regardless of the upper arbor's position. With this arrangement, it makes no difference whether the cutters have a diameter of 5¼ inches, as when new, or are reduced to the minimum diameter of 4½ inches, because the adjustment for changes in diameter can be made without introducing lost motion in the driving gears. The upper arbor is driven by a bronze gear on the intermediate shaft, which is in mesh with the steel gear on the lower arbor.

In order to change the gangs of cutters for slitting different widths, it is only necessary to remove two cap-screws at the foot of the outboard housing, slide the housing clear of the arbor ends, release a lock-pin and adjusting screw and swing the upper arbor up and away from the lower one (see Fig. 2). The ease with which cutters can be changed will be appreciated where different widths of stock are required.

The machine is driven by a sensitive clutch pulley, the

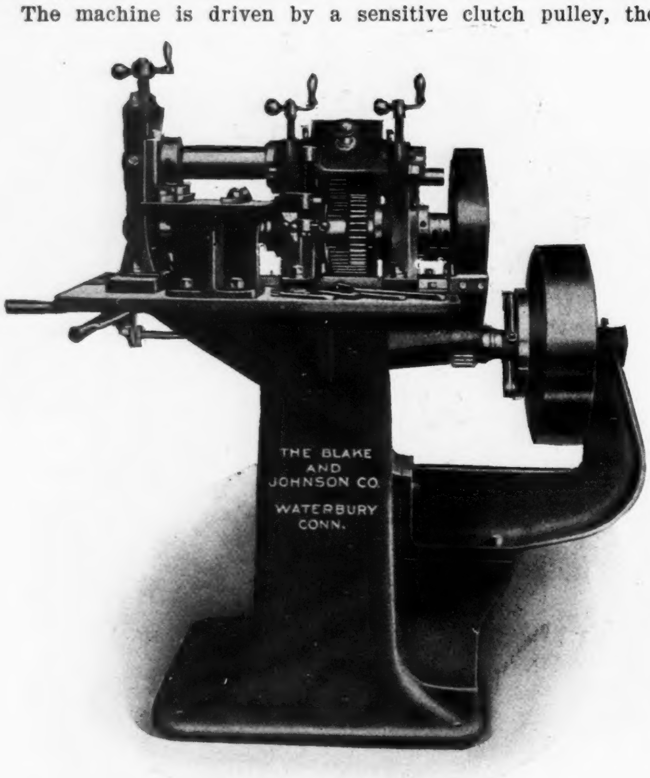


Fig. 1. Blake & Johnson Gang Slitting Machine

clutch of which can be operated either from the front or rear of the machine, or from a considerable distance by means of a suitable rope connection. The clutch pulley is 16 inches in diameter and has a 4-inch face, and the power is transmitted through back-gears having a ratio of 4.2 to 1. All the bearings of the machine are bronze-bushed and the arbors are made of crucible steel. This slitter has a capacity for stock up to 6 inches wide and is especially adapted for slitting steel

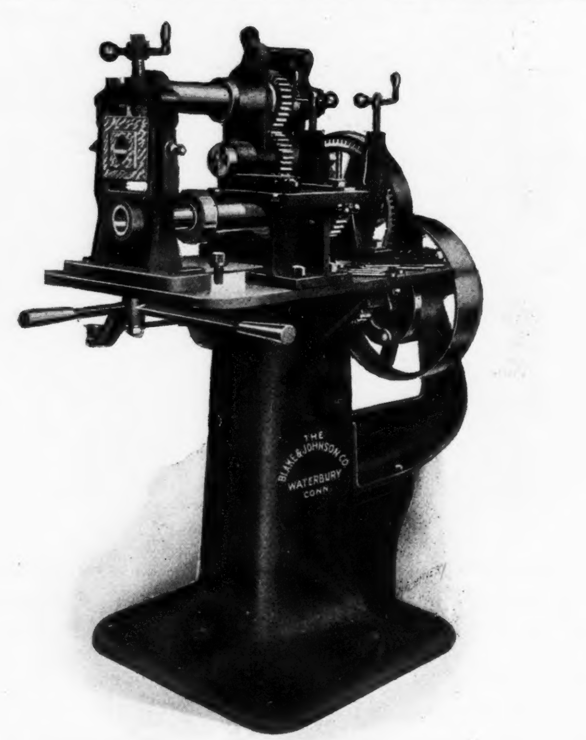
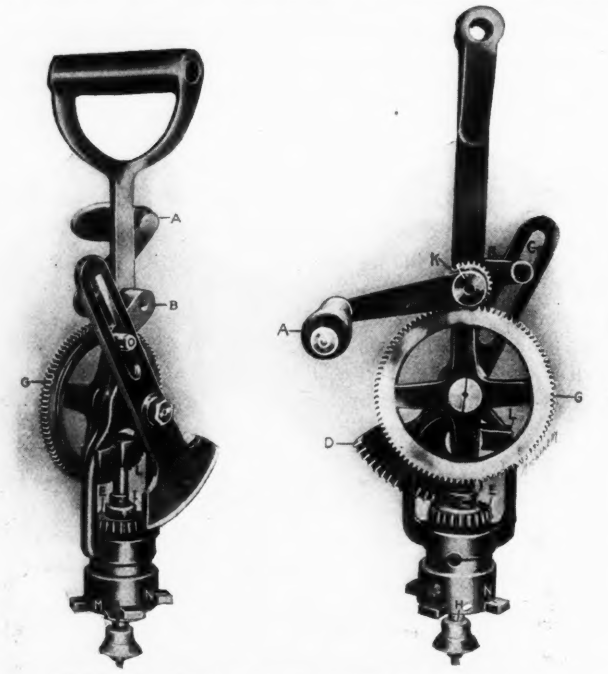


Fig. 2. Slitter with Housing moved back for changing Cutters

AUTOMATIC VALVE GRINDER

The valve grinder illustrated herewith is intended for grinding the valves of gasoline engines. This grinder gives a continuous cycle of operations, so that the valve is evenly ground and accurately seated. The valve is rotated in opposite directions in its seat and is progressively advanced periodically in one direction. First the valve is reciprocated on its seat a



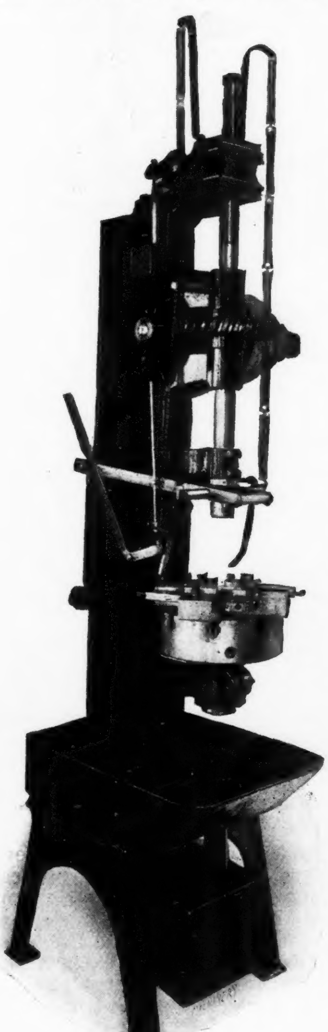
Specialty Machine Co.'s Hand-operated Valve Grinder

given number of times; it is then lifted, and when released by a suitable cam is automatically placed in a different angular position on the seat, after which it is automatically moved forward through a given angle and again reciprocated. The operation of this grinder is as follows: When the handle *A* is turned, crank *B*, which engages slot *C*, imparts an oscillating motion to segment *D*, which reciprocates the small pinion *E*. This pinion, through clutch *I*, transmits motion to the driving spindle *H*. At the same time, gear *G* is driven by a small pinion *K*. Located on the inside of gear *G* there is a cam which periodically comes under a roller mounted on carrier *L* and lifts clutch *I* from engagement. The clutch remains disengaged until pinion *E* is rotated through a given

arc, when the cam drops the clutch back into engagement. This movement effected by the cam also lifts the valve from its seat. Spring M engages the clutch at the proper time and insures a constant grinding pressure. The compression of this spring varies in accordance with the size of valves which are to be ground. The weight of the tool and downward pressure of the operator is carried by shoulder N which rests on the valve opening of the engine. This automatic valve grinder is being manufactured by the Specialty Machine Co., 95 Liberty St., New York.

BICKFORD UPRIGHT TAP-THREADING MACHINE

The Bickford Machine Co., Greenfield, Mass., has placed on the market a new machine for threading taps. This machine is an upright design, as the accompanying engraving shows. The taps are threaded by a die-head located below the spindle and supported by a foot projecting from the vertical column. The spindle rotates the tap blank being threaded, and, at the same time, is fed downward by a lead- or master-screw. The spindle is revolved by means of coarse-pitch worm-gearing having a ratio of about ten to one. The worm is carried by a horizontal shaft located near the top of the machine. This shaft is driven by a three-inch belt connecting with the cone pulley seen to the right of the worm-gear, and the latter transmits the motion to the spindle.



Bickford Tap-threading Machine

The lead-screw is in the form of a threaded shell. It is located on the upper end of the spindle and is engaged by half-nuts operating in a slide which forms part of the main column. The lower end of the spindle carries a holder for driving the tap blank, and the latter, when threaded, drops through the base of the machine. The spindle also carries (but does not revolve) a horizontal bar to which is attached, from above, pull-strings which return the spindle upward to its normal position when the half-nuts are released from the lead-screw. This disengagement of the half-nuts is effected by a trip which can be set to act just after the threaded tap drops from the holder.

In operating the machine, the square shank of the tap blank is inserted in the holder at the lower end of the spindle, while the machine is running. The tap is held in position with one hand and the spindle is pulled down with the other (until the tap enters the die) by means of the short cross-handle seen in front of the spindle. The tap blank is then released and the lever on the left (which has a chain at tached to its short arm) is pulled over, which engages the half-nuts with the lead-screw, thus causing the spindle to feed downward.

Lead-screws and half-nuts of different pitches are easily applied to the machine, and, if desired, they can be furnished with an increased lead to compensate for shrinkage in hardening the taps. A generous stream of oil is supplied to the work by a pump at the rear, which is driven from the countershaft. The lower bearing for the spindle can be removed easily, and, when this is detached, a much longer spindle travel is obtained. This feature adapts the machine to the threading of stay-bolt or other taps having long threads. The machine has a capacity for taps varying from one-half to two inches in diameter, and the same set of chasers can be used on any size tap having the same pitch of thread.

The company recommends the installation of two machines so that when threading large taps which require two cuts, the machines can be used in conjunction with each other. The threading die employed is a solid adjustable type having milled chasers. This die is efficient and produces accurate work. The total height of this machine is 8 feet 4 inches, and the weight about 1200 pounds.

SELLEW COMBINATION DISK GRINDER

The disk grinder shown in the accompanying engraving is built by the Sellew Machine Tool Co., Pawtucket, R. I. This is a combination grinder, one end having a 14- by 2-inch carborundum wheel for general work, and the other, a 20-inch disk wheel. The grinding wheel is enclosed by a substantial safety guard, carrying an adjustable support with rests so arranged as to enable the operator to work either on the front or side of the wheel. This equipment can be removed quickly for attaching buffing wheels, drums, etc. The spindle has a safety cap nut on its threaded end. The twenty-inch disk has a swinging table on the outer or finer side, which can be tilted for angular work and clamped in its tilted position. On the inner or coarse side of the disk, there is a stationary rest which can be used for supporting the work while taking

Sellew Combination Disk Grinder

roughing cuts or, if necessary, it can be swung down out of the way altogether. If desirable, both ends of the machine can be equipped either with disks and swinging tables or with grinding wheels.

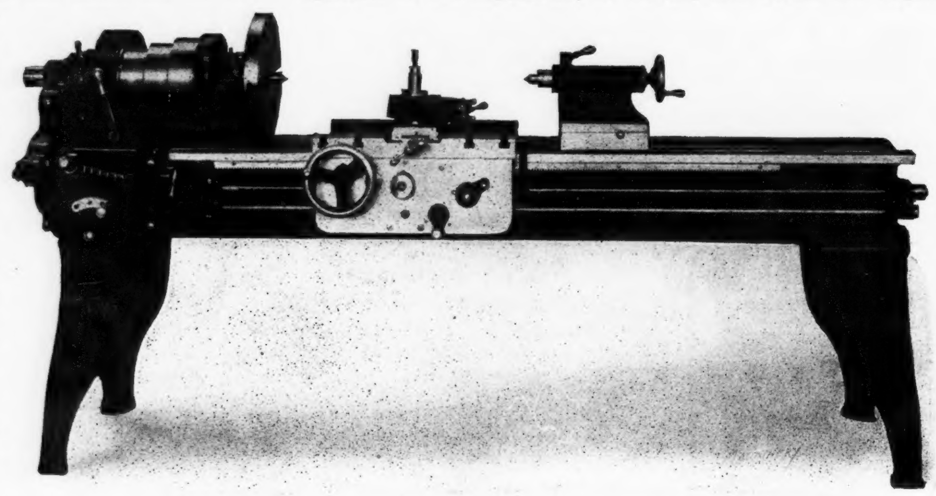
The spindle of this grinder was made exceptionally long in proportion to the diameter of the disk, to eliminate excessive wear of the journals and vibration. The length of the spindle over-all is 40 inches and the journals measure 2 by $7\frac{1}{4}$ inches. The journals are self-oiling and have ball bearings to take endwise thrusts. These bearings are protected by felt dust-guards. The spindle driving pulley is somewhat larger in diameter than the loose pulley, in order to relieve the tension of the belt when it is shifted to the loose pulley. The weight of the machine, complete with the necessary equipment, is 1600 pounds.

CONOVER-OVERKAMP QUICK CHANGE GEAR LATHES

The Conover-Overkamp Machine & Tool Co., Dayton, Ohio, is now manufacturing the quick change gear lathe shown herewith. This design is made in 14- and 16-inch sizes and with either a large three-step cone and friction double back-

gears, as shown in the illustration, or with a five-step cone and single back-gears. These machines can also be equipped either with a quick change gear box, as illustrated, an all-geared feed-box, or a standard belt feed-box and change-gears. Each of these boxes is an independent unit and they are interchangeable. This feature makes it possible to attach any one of these three units to the lathe at any time; that is, either a quick change gear box, a geared feed-box or a belt feed-box.

All gears in the boxes are steel and the bearings are bronze-bushed and can easily be renewed, in case of wear, without affecting the center distances or alignments. The boxes are fastened to the bed by four bolts and can easily be attached or removed. The change gear box, the geared feed-box, and the belt feed-box, are simple designs and there are no overhanging parts at the end of the lathe. The quick change gear box contains a driven shaft carrying a tumbler gear which can be engaged with any one of the eight cone gears. In constant mesh with the cone gears, there is an intermediate shaft provided with four gears, and a set of sliding gears can be engaged with any one of the intermediate gears by means of the lower lever seen at the front of the box. With this arrangement, thirty-two changes are obtained with but two operating levers and without removing or changing a single gear. A stud is provided on the reverse quadrant for compounding or for the introduction of special gears, so that special or metric threads can be cut with the standard lead-screw. The geared feed-box has four changes and is operated by one lever. The changes are obtained through sliding gears and positive clutches. The belt feed-box is equipped with a belt tightener.



Quick Change Gear Lathe built by Conover-Overkamp Machine & Tool Co.

These lathes can be furnished with standard legs, cabinet legs and also with short legs and oil pans. A taper attachment can be added at any time, as all carriages are planed and drilled for this purpose before the lathe is shipped.

NEW MACHINERY AND TOOLS NOTES

Precision Boring Head: Precision Tool Co., Lansing, Mich. A new precision boring tool for use in fine miller work and similar classes of service. This tool is equipped with an adjusting screw to adjust it for any size of radius work, the screw being provided with a micrometer attachment for securing any radius that is required.

Spiral Cutter Grinder: Sloan & Chace Mfg. Co., Newark, N. J. A spiral cutter grinder, semi-automatic in its action, which has an emery wheel four inches in diameter. The machine will grind an eight tooth 45 degree angle cutter in three minutes. The wheel spindle is fitted with S. K. F. ball bearings and the work is held between centers.

Mandrel Press: G. T. Eames Co., Kalamazoo, Mich. A mandrel press provided with a leverage system which multiplies the applied force by three hundred. This press is equipped with a square ram and is operated by a rack and pinion; it has a lock-nut that enables the ram to be clamped in any position while adjusting the work. These presses are made in a variety of lines and sizes.

A Group of Special Lathes: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. A special manufacturing lathe, designed with the jack shaft under the bed so that the machines can be grouped together and arranged for any desired speed. The driving pulley is loosely mounted on the spindle and is engaged by means of a friction clutch; the lathe headstock is cored out to permit the passage of the driving belt.

Metal Cutting Machine: Racine Tool & Machine Co., Racine Junction, Wis. A new type of metal cutting machine equipped with a three speed attachment designed to give speeds of 60, 90 and 125 R. P. M. respectively, when cutting unannealed tool steel, annealed high-speed steel and mild steel. The general construction of the machine follows the lines which are now generally recognized as standard for equipments of this type.

High-Speed Hacksaw Machine: E. C. Atkins & Co., Indianapolis, Ind. A high-speed hacksaw machine known as the No. 7 "Kwik Kut," equipped with a swivel vise and independent motor which has a speed range of 550-1100 R. P. M., and drives by means of a Morse chain running over hardened steel gears. The machine is provided with the most modern type of lubrication system and method of raising the saw on the idle or return stroke.

Electric Drilling Machine: Van Dorn & Dutton Co., Cleveland, O. An electrically operated drilling and reaming machine which has a drilling capacity of one-half inch in steel and one inch in wood, and a reaming capacity of 7/16 inch. The machine is 14 inches high from the top of the handle to the bottom of the chuck, and weighs 17 pounds. It is designed to operate at a speed of 700 R. P. M. and can be furnished for connection with either 110 or 220 volt lines.

Multiple Drilling Machine: Taylor & Fenn Co., Hartford, Conn. A machine equipped with a multiple head that is built with from two to fourteen spindles. The position of these spindles is not adjustable, so that special heads are required for each class of multiple drilling that is to be done. The spindles are gear-driven, and as the gear ratio is arranged to provide the proper speed for various sizes of drills, it is necessary to specify the size of drills that are to be used.

Double Arbor Buffing and Polishing Machine: Excelsior Tool & Machine Co., East St. Louis, Ill. A special design of buffing and polishing machine which has two independent spindles, giving a combination of handiness of operation, simplicity, and large capacity. The entire machine is enclosed by dust-proof covers and has a solid bracket for attaching the dust hood. The machine is designed to run at a speed of 300 R. P. M., although this figure may be varied slightly to meet the requirements of individual classes of work.

Revolution Counter: American Ever Ready Co., 304 Hudson St., N. Y. City. A new type of revolution counter that is shaped somewhat like a revolver and of about the same size. The starting and stopping of the counting mechanism of this device are not dependent upon the amount of pressure applied in holding the counter against the revolving spindle. The counting mechanism is started and stopped by operating a trigger, and the recorder indicates in the forward direction regardless of the direction of rotation of the shaft.

Belt Surface Grinder: Peerless Surface Machine Co., Newark, N. J. A line of belt surface grinders of both vertical and horizontal types, and of different sizes for a variety of classes of work. These machines are provided with an endless belt upon which the abrasive material is mounted, and a work table that can be swung to any desired angle. The bearings in which the spindles of the belt pulleys run are provided with boxes of the sliding type, which enables any stretch in the belt to be taken up. A dust collector is arranged to catch the metal dust which is removed from the work.

Plain Radial Drilling Machines: Dreses Machine Tool Co., Cincinnati, O. These machines are of the 3- and 3½-foot size, and are similar in construction to the 5-, 6-, and 7-foot sizes illustrated in November, 1911. They are designed for the use of high-speed drills, are convenient to operate and substantially built. The outer column swings on a fixed inner column extending to the top, and there is a third bearing in the middle which greatly increases the strength and rigidity. The arm is of box, parabolic shape and the lower rib is double-webbed, thus giving great resistance to bending and torsional strains. The head has long and wide bearings on the face of the arm, and, in addition, a third bearing at the rear. This third bearing gives extra support to the head, prevents bending the rear shaft, reduces the wear of the bevel gears and bearings and distributes the torsional strain over the entire arm. The spindle has twenty-one speeds, runs in phosphor-bronze bearings and is driven by two keys. The driving gear of the spindle rests and revolves on a ball bearing, which is said

to effect a power saving of 15 per cent. The feed is all-geared and there are eight changes which can be varied while drilling, by a handle located on the head. There is an automatic stop and depth gage; a quick-return having four handles, either of which can be used for engaging or disengaging the feed; and a tapping, starting and stopping mechanism of the frictional type, operated by a conveniently located lever.

* * *

BORING MORTAR CARRIAGES

At the Builders' Iron Foundry, Providence, R. I., some interesting work is going through in connection with the making of disappearing carriages for mortars for the U. S. Government. These mortars are of the 12-inch size, model 1896—M—III, and will be used for coast defense. One of the trunnion castings is shown in Fig. 1. This casting weighs 5620 pounds,

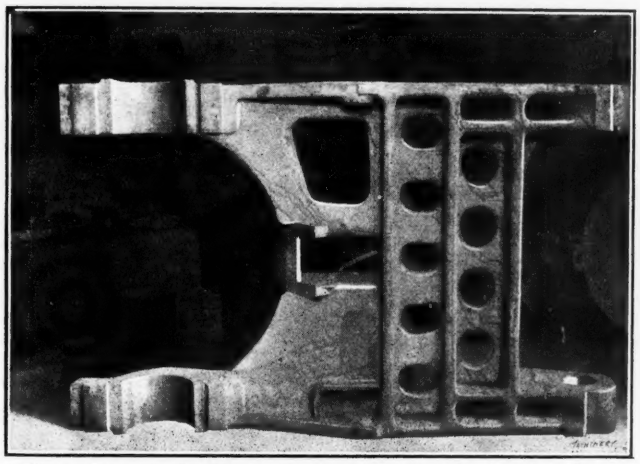


Fig. 1. Disappearing Mortar Carriage Casting being bored in Fig. 2

and the boring operations on it well illustrate the general character of the work.

This work consists in the boring of the large trunnion holes at one end, the fulcrum pin holes at the opposite end, and miscellaneous smaller holes between the two ends to receive the intermediate and elevating shafts. In doing this work a universal boring machine is used, as shown in Fig. 2. In order to facilitate the handling of the work upon this machine a special table was made to assist in supporting the work while being operated on. This will be observed in place on the machine beneath the casting. Before the casting is bored, however, the trunnion ends are milled and fitted with the bearing caps. This being done, the casting is mounted on a fixture and the fixture supported on the machine in position for boring the trunnion holes, which are finished to a size slightly over 13 inches. It is important that this dimension be very accurate. It will be observed that the casting is too large to be supported wholly on the table of the machine, and it is necessary to support the outer end upon jacks which may be seen in Fig. 2. This part of the work being done, the casting is reversed, and, by supporting a test-bar in bearings which have been provided in the trunnion end of the fixture, a convenient means is afforded for taking measurements when boring the fulcrum pin holes. This is the operation shown being done in Fig. 2. After both ends have been bored, the several smaller bearing holes for the intermediate and elevating shafts are bored at intermediate positions between the ends of the casting.

The work is under the direction of a government inspector, and the limits allowed are extremely close in regard to diameters of holes, distances between holes, and parallelism.

* * *

TO DISTINGUISH BRASSES BY COLOR

The composition of the brasses (copper and zinc alloys) may be readily determined, approximately, by the color. The method gives a brass founder a simple and rapid means for ascertaining what his brass contains. The following shows the color of the various percentages of copper and zinc:

When the brass contains 5 per cent of zinc, it has a red color scarcely differing from that of pure copper. When 10 per cent of zinc is present, the mixture has a true bronze color. With 15 per cent of zinc, the brass has a light orange shade. When the amount of zinc reaches 20 per cent the color of the mixture is greenish-yellow and is known as "green brass." With 25 per cent zinc, the color is practically that of the 20 per cent mixture so that this, too, is a "green brass." Brass with 30 per cent zinc has the true, yellow brass color. The same is found with 35 per cent of zinc, but at about this point the yellow color begins to disappear, for at 40 per cent zinc a reddish yellow color is found. Brass, therefore, that has a reddish-yellow shade will always contain more than 35 per cent zinc. The "dead line" seems to be about 38 per cent zinc, for at this percentage, the transition from the real yellow to the reddish-yellow begins.

When the zinc is increased to 45 per cent, the color of the brass is a rich golden shade and, strictly speaking, it may be called "orange." The mixture containing 50 per cent zinc has also a golden shade, but even richer than 45 per cent zinc alloy. At 55 per cent zinc, the color resembles that of 14-karat gold. When 60 per cent of zinc is reached, the brass has a yellowish white shade, and as the quantity increases, the color becomes white and finally gray.

It becomes possible, then, to make an approximate determination of the composition of a brass by the color. If it is very soft and red or orange color, then the amount of zinc is from 10 per cent to 15 per cent. If greenish-yellow, the quantity of zinc ranges from 20 per cent to 25 per cent. The true brass color is found when the zinc amounts to from 30 per cent to about 38 per cent. If, however, it is found that the brass is hard and has an orange yellow color, then the zinc must be present in an amount greater than 38 per cent. To cite an instance of this kind, a concern may be purchasing yellow-brass ingot. If, upon cutting or filing it, the color is found to be orange, then the zinc in it is excessive and may run from 40 per cent to 50 per cent.

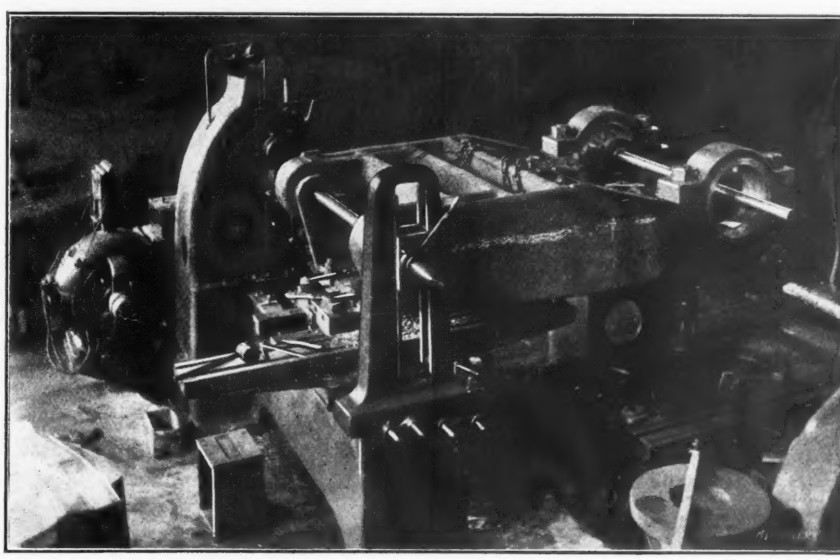


Fig. 2. Boring a Disappearing Mortar Carriage Casting on a Universal Boring Machine

In comparing the color of the brasses, a highly polished surface is not as suitable as a dead one for the reason that false reflections are apt to deceive the observer. A surface that has been filed or ground is preferable, and in order to avoid tarnishing the metal should be freshly cut when a comparison is to be made.—*Brass World.*

* * *

The following method for preventing short-paid postage on letters to foreign countries has been adopted by a large firm having a considerable amount of foreign correspondence: Different-colored envelopes are used by the stenographers when addressing letters to foreign countries. The stamping clerk first of all segregates the letters according to the color of the envelopes and then stamps them as required. Mistakes become very rare under this system, and the simplicity of the system recommends it for use.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The eleventh annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, Wednesday, Thursday and Friday, October 16 to 18. The meeting was called to order at the morning session on October 16 by the president, E. P. Bullard, Jr., who referred to the work of the association in a brief address. The remainder of the session was given over to the reports of committees. The membership committee reported applications for membership from the following firms:

Beaman & Smith Co., Providence, R. I.
Blake & Johnson Co., Waterbury, Conn.
Turner Machine Co., Danbury, Conn.
Union Twist Drill Co., Athol, Mass.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Zeh & Hahnemann Co., Newark, N. J.

These firms were elected to membership, making the total number of members 188. Reports were also submitted by the committee on standardization, foreign relations, patents, and investigation of cutting tools. A resolution was passed, after some discussion, making a change in the membership fee—graduating it according to the capital and surplus of the respective members.

During the afternoon session, October 16, and the morning session, October 17, the following papers were read:

"Export Trade," by W. A. Viall, of the Brown & Sharpe Mfg. Co., Providence, R. I. (See abstract in this number.)

"The Use of an Association Catalogue in the Development of Foreign Markets," by Stanley H. Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn.

"How United States Patents might be made of Greater Value to Patentees," by Samuel W. Banning of Banning & Banning, patent attorneys, Chicago, Ill.

"Tariff Legislation and its Influence on the Machine Tool Trade," by C. Wood Walter, of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

"How could the Association be benefited by the Formation of a Mechanical Section?" by E. J. Kearney of the Kearney & Trecker Co., Milwaukee, Wis. (See abstract in this number.)

The sessions on the afternoon of October 17 and the morning of October 18 were devoted to committee meetings on lathes, sensitive drilling machines, boring machines, gear cutting machines, grinding machines, hand screw machines, planing machines, radial drilling machines, milling machines, shaping machines, vertical drilling machines, and turret lathes.

It was decided to hold the next spring meeting in New York City. The following officers were elected for the coming year: president, E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, A. T. Barnes, of the W. F. & John Barnes Co., Rockford, Ill.; second vice-president, R. K. LeBlond, of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio; treasurer, A. E. Newton, of the Reed-Prentice Co., Worcester, Mass.; and secretary, C. L. Taylor, of the Taylor & Fenn Co., Hartford, Conn.

The Association Catalogue

The paper by Mr. S. H. Bullard aroused considerable interest on account of the novelty of the idea presented, and was followed by an animated discussion. The idea proposed is, briefly, that the association should publish a catalogue for distribution mainly in foreign countries, in which the product of every member should be represented, this catalogue to be printed in English, German, French and Spanish. Apparently most of the members present favored the idea. A committee was appointed to further work out the details, and this committee reported at the last session, October 18, the report being to the effect that a permanent committee should be appointed and that the details of the issuing of a catalogue as proposed should be taken up by letter ballot with the members. At the same meeting a special committee was decided upon to report to the association at its next meeting on the question relating to the formation of a mechanical section raised by Mr. Kearney's paper on the subject.

Patents and Patent Legislation

The paper on patents and patent legislation, by Mr. S. W. Banning, contained a review of the Oldfield bill now before Congress, which is designed to eliminate certain alleged abuses which have grown up during the old patent law. The speaker referred to the main features of the bill (see MACHINERY, July, 1912, "Proposed Changes in Patent Laws"), and particularly gave attention to the compulsory license clause against which he presented an argument. The section of the bill referring to restrictions with respect to the resale or use of patented machines after the title to such machines has passed from the manufacturer, was also referred to, as well as the conditions where contributory infringement is claimed on account of the use of accessories with the patented machine which are not secured from the seller of such machine. The stand taken by the speaker was that when the restriction is one that relates exclusively to the patented invention, it should be amenable to the remedy provided for enforcement of the inventor's rights in an infringement suit; but when the restriction is one that relates to supplies of a general nature, the question is one outside the realm of patent infringement and one that should simply be decided as a question of breach of contract, the validity of the contract to be decided in ordinary court proceedings. It was pointed out that under present practice the patent may be used as a weapon to enforce control of the use and sale of articles that are not even accessories to the machine patented and which are wholly unrelated to its use. As an example, the patentee of an adding machine may sell it with the restriction that its use is conditional upon the purchase from the same source of all typewriters required by the user, and under penalty of suit for infringement of the adding machine patent. In this way, the present law would permit the patentee to extend his monopoly to cover a device upon which he has no patent and which bears no relation to the invention actually protected. Reference was also made to some questions not included in the Oldfield bill.

Under the present practice the inventor is required to append to his specification one or more claims which point out and limit the invention, and which are intended by their language to distinguish it from all prior inventions. The invention is considered as a concrete embodiment of certain mechanical parts or elements, and the claim is restricted to this physical combination. The real invention, however, may go a great deal deeper than this, and in the case of basic inventions it is the underlying principles and not the mechanical embodiment which is of value and importance; but under present practice, inventions of this kind are the more difficult to adequately protect. Minor improvements are easily claimed in mechanical language, even when they are merely new mechanical embodiments of old basic ideas.

The speaker advocated that the inventors should be allowed to claim the functional co-relation of the parts in such a way as to cover every physical embodiment of the same fundamental principle. In this respect, the German practice is quite the reverse of the American practice. In Germany, the claim is directed to the basic functions of the elements involved, and this the speaker considered ought to be the case also under our patent laws. Under the present practice, the unnecessary strictness in claiming the invention, and the oftentimes ill-advised liberality of the courts in construing the claims, renders it extremely difficult to determine the rights of the patentee.

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AMERICAN MACHINIST'S THEATER PARTY

The *American Machinist* followed its custom of some years standing by entertaining a theater party of several hundred machine tool builders, mechanical engineers and representative men in metal manufacturing lines, during the meeting of the National Machine Tool Builders Association in New York. The party saw the French comedy "Oh, Oh, Delphine!" played at the Knickerbocker Theater, Thursday evening, October 17, and was highly entertained by the spicy witticisms and catchy songs of this brilliant hit of the season.

* * *

The *Boletin de l'Industrie Minerale* states that aluminum wire is being extensively used in Europe for electric transmission lines, on account of the saving in first cost. The initial cost of an aluminum line is about 25 per cent less than an equivalent copper line, all items considered.

MACHINERY'S 1912 OUTING

MACHINERY's tenth annual outing for machine tool builders, dealers and others connected with the machine tool industry, including many superintendents of manufacturing plants, took place on October 19.

MACHINERY's steamer left the foot of East Twenty-fourth St. at 11 A. M., stopping first at the Brooklyn Navy Yard, the most important naval station in the United States, where Uncle Sam's new super-dreadnought, the 27,000-ton battleship *New York* is now under construction. The keel was laid in September, 1911, and she will be launched before this item is read. The Commandant and his aide had been suddenly ordered to Washington the night before, and through some oversight the arrangements made for the entertainment of the party were not carried out; but opportunity was afforded to inspect the yard and go aboard the battleships *Utah, Florida* and *Connecticut.*

Luncheon was served while at the Navy Yard, and immediately afterwards the steamer started up the East River and around Manhattan Island, passing through the Harlem River and shooting some fourteen bridges that span it, returning to the foot of East Twenty-fourth St. on time. The steamer was the largest that ever passed through the Harlem River, and it was a close call getting through High Bridge.

An unexpected feature of the outing which was highly enjoyed by the friends of Mr. Charles E. Hildreth, for some years secretary of the National Machine Tool Builders Association, was the presentation to him of a cake well covered with candles, in honor of his birthday, which happened to fall on October 19. A song especially written for the occasion was sung with gusto, and Mr. Hildreth responded feelingly.

MACHINERY's outing was started ten years ago with a tally-ho ride given to twenty-one manufacturers and others present at the convention in New York at that time, and the attendance has now increased so that between five and six hundred representative men in the machinery industry meet each year to renew and extend their acquaintance and to spend a few social hours on that occasion.

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PRICE SHEETS FOR SALESMEN

Loose-sheet price books have come into common use by machinery salesmen in the past few years. The page most used is of thin paper printed on one side only, cut to the standard, 4 inches wide and 7½ inches long, with three holes punched on three-inch centers, and with round corners. A sample page was shown in the April, 1912 number of MACHINERY on page 593, engineering edition. A well-known western machinery dealer is establishing among machine tool manufacturers for the use of their salesmen similar sheets printed on both sides and made of light weight tag stock, that is, white filled linen, which, of course, is much stronger and more durable than the thin paper commonly used. These sheets carry illustrations of machines on one side and the specifications on the other. The texture of the stock being coarse, it is advisable to illustrate with wood cuts or coarse screen half-tones, the illustrations being used simply to identify the machines and not to show details of construction clearly.

* * *

Thin steel saws for slotting heads of machine screws and bolts are tools which require frequent renewal. The work is very destructive and, ordinarily, the tools do not last long. However, one of these slitting saws, made of "Ark" high-speed steel, recently slotted 477,000 stove bolts before giving out.

NEW YORK ELECTRICAL EXPOSITION

The sixth annual electrical exposition, held in the Grand Central Palace, New York City, October 9 to 19, included a variety of interesting applications of electricity. The majority of the exhibits were of a nature to interest non-technical visitors, as they consisted of electrical devices used for household and office purposes. The exposition was opened with a luncheon in honor of Thomas A. Edison, commemorating the completion of thirty years of Edison service in New York City, given by the New York Edison Co., October 9. Mr. John W. Lieb, Jr., general manager of the New York Edison Co., related how the industry has grown since the opening of the historic Pearl St. plant, September 4, 1882. Electrical plants thoughout the country are capitalized at $2,500,000,000, having an annual capacity of 12,000,000,000 K. W., and gross earnings of $4,000,000,000.

The exhibit of the New York Edison Co. showed the wonderful development in the application of electricity which has taken place in the past decade. This fact will be readily brought out by touching upon the statistics presented by this company's commercial engineering department. Without entering into detail, an idea of this development may be gained from the fact that in 1899 the total horsepower of the motors connected to the Edison Co.'s system in New York City was 34,457, while in 1911 this figure had increased to 312,863. This is but one of the increases in consumption of electric power which have taken place, and it will be evident that to keep pace with such an increase of power consumption corresponding increases in generating equipment were necessary. The developments which have been made along this line are clearly set forth by models of the old Edison station on Pearl St., N. Y. City, which was built in 1882, and the Waterside stations which are carrying the load at the present time. These models are constructed on a scale of one inch to two feet, and show the complete plants, together with the arrangement of the equipment. The old "Jumbo" generators of the first Edison station in New York, which were built by Armington & Simms, Providence, R. I., and placed in operation September 4, 1882, were run under the following conditions: rated capacity, 126 K. W.; capacity in 16-candlepower lamps, 1000; square feet of floor space occupied, 122.5; R. P. M., 350; weight of generating set in pounds per K. W., 488; K. W. per square foot of floor space occupied, 1.03. The present type of Curtiss turbine generators were built by the General Electric Co., Schenectady, N. Y., to operate under the following conditions: rated capacity, 20,000 K. W.; capacity in 16 candlepower lamps, 1,000,000; square feet of floor space occupied, 297; R. P. M., 750; weight in pounds per K. W., 42; K. W. per square foot of floor space covered, 67.34.

Another particularly interesting exhibit is that of the Electrical Testing Laboratories of New York City. Among the apparatus shown, there was a series of twenty-seven electric meters which cover a range of design from the old-fashioned electrolytic type, which was the first used in New York City, up to the most modern type of instrument. In this connection it may be of interest to mention that the method of measuring current with the old electrolytic type consisted of shunting a part of the current through a cell; the amount of current passed was then measured by the weight of metal deposited from the solution. The Electrical Testing Laboratories have one of the original balances which were used to weigh the metal deposited in this way.

One of the interesting features of the exposition was the exhibit of the American Museum of Safety. A large number of wax models of different parts of the human body affected by a variety of vocational diseases were shown. This is a subject which has not received much attention in this country, but which has been studied in detail in Germany. Dr. Wm. H. Tolman, director of the American Museum of Safety, has recently been in Germany making a study of the results of investigations of this subject which have been made there, and the models exhibited were brought back by him from Germany. It is the intention of the American Museum of Safety to issue circulars at a later date showing the causes of such vocational diseases and the means of prevention.

DOGS AND DRIVERS

A review article was published in the October number, engineering edition, illustrating a large number of dogs and drivers for lathe and milling machine work held on centers. Unfortunately, a description of the meritorious safety lathe dog illustrated in two styles in Figs. 1 and 2, which is made by J. H. Williams & Co., Brooklyn, was omitted. In this lathe dog, the square-head set-screw so dangerous to the workman's hands and arms, is displaced by square socket set-screws always lying flush with the surface of the screw hub or below it. Inasmuch as the set-screws do not project above the surface, they cannot catch the workman's sleeve or other parts of his clothing and thus cause injuries.

Figs. 1 and 2. J. H. Williams & Co.'s Safety Lathe Dogs

This lathe dog is essentially the same in design as the form used in the works of the National Tube Co., and illustrated in the April, 1911, number of MACHINERY. A feature of the design of the drop forged dog is the reinforcement at each side of the screw hub made to strengthen it at a critical point and to eliminate the part of the boss which would project if the lines were the same as on the square-head set-screw type. These safety dogs are made in the same sizes as the regular square-head set-screw type dogs.

Another dog worthy of notice which is especially adapted for milling taper work, spiral taper reamers and other taper parts held on centers, is the Hill compensating dog made by the Ready Tool Co., of Bridgeport, Conn., and shown in Fig. 3. Features of this dog are a forked driver mounted on the spindle or faceplate and a dog having a tail with a ball-shaped part engaging the fork of the driver. The point of application of the forked driver on the ball is in approximately the same plane as the end of the piece being indexed. The object of this is to eliminate the irregularity of action in indexing tapered work that inevitably follows the use of the ordinary bent tail dog when engaged with an ordinary driver, and arises from the sliding of the taper tail of the dog in and out of the slot and the necessary looseness of engagement of the tail in the slot.

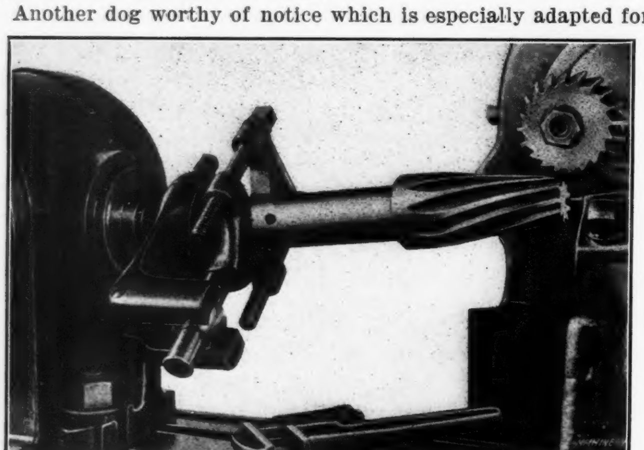

Fig. 3. Ready Tool Co.'s Milling Machine Dog

PERSONALS

Frank Koester, consulting engineer, has moved his office from 115 Broadway to larger quarters at 50 Church St. (Hudson Terminal Building), New York.

F. Mandon, manager of Fenwick, Freres & Co., Paris, France, is making a short visit to American machine tool building centers in the interests of his company.

E. G. Buckwell, secretary and manager of sales of the Cleveland Twist Drill Co., Cleveland, Ohio, sailed on the *Carmania* October 5, for a two-months' business trip abroad.

V. Brockbank, a British contributor to MACHINERY, has come to America and joined the National Twist Drill & Tool Co., Detroit, Mich., in the capacity of assistant superintendent.

E. J. Lees of the Lees-Bradner Co., Cleveland, Ohio, maker of gear hobbing machines, sailed for Europe October 1, on the *Mauretania*, for a five or six weeks' business trip in England and France in the interests of his company.

D. O. Barrett, superintendent for the past year-and-a-half of the Manitoba Engines Ltd., Brandon, Manitoba, and an occasional contributor to MACHINERY, has resigned to take charge of the experimental work of the Heer Engine Co., Portsmouth, Ohio.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, Ohio, who sailed for Europe May 25, returned early in October, having made an extended tour of British and Continental manufacturing centers in the interests of his company.

Ralph E. Flanders, advertising manager of the Fellows Gear Shaper Co., Springfield, Vt., has resigned to become manager of the Fay automatic lathe department of the Jones & Lamson Machine Co., Springfield, Vt., and also manager of the company's advertising.

Howard G. Carter will have charge of the equipment of the new $300,000 high school building in Hamilton, O. The school will have a completely equipped technical department including a machine shop, forge shop, foundry, pattern shop, stock-room, bench room and drafting-room.

Louis M. Pawlett has recently left the Locomobile Company of America, where he held the position of executive engineer, to enter upon a consulting practice in motor transportation engineering. For this purpose, Mr. Pawlett has opened offices in the new building of the U. S. Rubber Co., 1786 Broadway, N. Y.

John S. Myers, known to readers of MACHINERY as an occasional contributor of articles on machine design and other subjects, has resigned his position with the American Engineering Co. (successor to the Williamson Bros. Co. and the American Ship Windlass Co.) to go with the Southwark Foundry & Machine Co., Philadelphia, Pa.

J. McA. Duncan has been appointed district manager of the Westinghouse Electric & Mfg. Co. for the Pittsburg district, in place of Mr. W. F. Fowler, resigned. Mr. Duncan has been employed by the Westinghouse Electric & Mfg. Co. about twenty-five years, and is one of the group of eight men taken over from the Union Switch Signal Co., then located in Garrison Alley, Pittsburg, to form the electric company, which was first established at the same place.

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OBITUARIES

William H. Corbin, vice-president of the Joseph Dixon Crucible Co., Jersey City, N. J., died at his country home in Sullivan Co., N. Y., September 25, aged sixty-one years.

Stephen Holman, founder of the Holyoke Machine Co. of Worcester and Holyoke, Mass., died at his home in Swampscott, October 13, aged ninety-two years. Aside from his machine building industries, Mr. Holman was also for many years in the cotton industry, and was a leader in the National Association of Cotton Manufacturers. He was a graduate of Williams College.

Horace Inman, president of the Inman Mfg. Co., Amsterdam, N. Y., died October 16, aged seventy-three years. Mr. Inman was widely known because of his invention of automatic and semi-automatic paper box machinery. He was one of the three mechanics who received a diploma at the World's Columbian Exposition at Chicago, the other two being Ambrose Swasey and Edwin Reynolds.

* * *

The replacing of forty-four consolidation engines by twenty-five Mallet compound locomotives on the Hinton Division of the Chesapeake and Ohio Railroad, has resulted, it is stated, in a saving of 37.55 per cent of the cost of handling the freight traffic on this division. As the Mallet locomotives are more costly than were the consolidation locomotives, this saving is reduced by the amount of the interest and depreciation of the excess cost of the Mallet engines. Neverthelsss, there appears to be a clear saving of more than 30 per cent of the total cost of handling the freight traffic.

A NEW METHOD OF REVEALING SEGREGATION IN STEEL INGOTS

The description given by Sir Robert Hadfield in a paper on the above subject, presented before the September, 1912, meeting of the Iron and Steel Institute, is closely related to the text of his paper describing his methods of producing sound ingots, which was also presented at this meeting. The object of the present paper is to describe a method of studying the conditions under which segregation takes place with the view of arriving at some method of eliminating, or at least checking, the formation of segregated sections.

Segregation may be briefly described as the tendency for objectionable impurities in steel—particularly sulphur and phosphorus—to be concentrated at the center of the ingot. The material constituting such segregated sections is defective in strength, and when rails or structural material are rolled from ingots containing such defects, the strength of the resulting product is seriously impaired. Like piping, segregation is caused by the unequal rate at which the solidification of the ingot takes place. It will be remembered that the inner portions are last to solidify, and experience has shown that there is a tendency for the sulphur and phosphorus to be concentrated in these sections by liquidation.

In starting to investigate the conditions responsible for segregation, it was reasoned that the addition of some metallic material could be made to the steel while in its molten form which would throw light upon the subject. A number of experiments were conducted with various metals, and copper was finally selected for the purpose because its specific gravity is slightly greater than that of steel, and also because its color would make its presence apparent when the ingot was broken up. The results of experiments conducted along this line brought out several interesting points. A sand head was used on the ingot molds in order to maintain a liquid riser at the top, and additions of molten copper made at different lengths of time after pouring the steel penetrated those portions of the ingot where piping usually takes place, and thus indicated the exact location where inter-crystalline unsoundness or segregation is developed. It may be mentioned in this connection that such inter-crystalline unsoundness is not seen in the fracture of an ordinary ingot when cold; it is revealed upon a polished and etched section. By making additions of copper at different lengths of time after pouring the ingot, the rate at which the solidification of the steel takes place was determined, as the copper was unable to penetrate steel which had already reached the solid form. It may be mentioned in this connection that these experiments proved that the steel in the inner portions of the ingot remains in a liquid condition for a far longer period of time than was supposed. It can, therefore, be readily understood why there is a greater tendency towards segregation in large ingots. The obvious conclusion is that the greater length of time in which the metal remains in a molten condition offers a greater opportunity for the concentration of sulphur and phosphorus in the central section. This is in line with a long-known fact that the more rapidly solidification takes place, the greater is the reduction of the tendency towards segregation.

The author believes that these experiments should throw some light upon the nature of the phenomena which occur in the cooling down of molten steel to a solid condition, and it would appear that the method outlined presents a valuable source of information in regard to conditions affecting the rates of cooling, segregation and liquidation of steel.

* * *

A pin should not be put through a shaft that transmits a considerable amount of power. If collars or other parts have to be fastened to the shaft, it is better to hold them with one or two keys, as the weakening effect on the shaft of the keyways is not as great as that of a pin hole.

* * *

COMING EVENTS

November 11-16.—Second International Exposition of Inventions in St. Louis, Mo. F. W. Payne, secretary-manager, St. Louis Coliseum Co., St. Louis. Inventions covering a wide scope will be shown, applicable to every profession or trade.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION. Official report of the semi-annual convention at Atlantic City, N. J., May 16 and 17. James H. Herron, general manager, Cleveland, O.

AMERICAN ASSOCIATION OF COMMERCE AND TRADE, Berlin, Germany. Year-book giving officers, board of directors, roll of members, standing committees, annual reports, proceedings at annual meeting and statistics.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN held its annual meeting in Teachers College, Columbia University, October 1. This meeting was the most important yet held by the organization. A chart was displayed by the president, Mr. E. Farrington Chandler, showing that the membership had quadrupled in the past year. A program comprising interesting constructive features was adopted for the coming year, which included the establishment of a mutual benefit section. The officers elected for 1913 are: Prof. Charles W. Weick, of Columbia University, president; William B. Harsel, first vice-president; and Charles A. Clark, of the Crocker-Wheeler Co., second vice-president. Walter M. Smyth, 116 Nassau St., New York, is the secretary.

NEW BOOKS AND PAMPHLETS

DIGEST OF WORKMEN'S COMPENSATION LAWS. 56 pages, 6 by 9 inches. Published by the National Association of Manufacturers, 30 Church St., N. Y. Library edition, 30 cents; paper cover, 15 cents.

A large number of bills concerning compensation of injured workmen have been presented to the state legislatures for enactment during the last two years. The purpose of this work is to form a reference work for the legislator, lawyer, insurance expert, employer and employe in the form of a synopsis of each law, so arranged that a comparison of the laws can be made easily. It is a work that should be available in every manufacturing plant.

THE FREEZING POINT, BOILING POINT AND CONDUCTIVITY METHODS. By Harry C. Jones. 75 pages, 7¾ by 5½ inches. 15 illustrations. Published by the Chemical Publication Co., Easton, Pa. Price $1.

In preparing the second edition of this book, the author has gone over the text with the view of correcting a few minor errors which existed in the first edition, and has also made the necessary changes to bring the work up to date. The usual texts dealing with this subject have been prepared to meet practical requirements of the laboratory or the theoretical considerations which are dealt with in the class-room. The present book has been compiled with a view of combining the theoretical discussions and practical laboratory methods in the same volume, as it is believed that this is the only way in which an adequate knowledge of the subject can be secured.

STEAM BOILERS. By W. Inchley. 412 pages, 7½ by 5¼ inches. 140 illustrations. Published by Longmans Green & Co., New York City. Price $2.40.

An attempt has been made in the presentation of this text, to produce within the confines of a book of reasonable size, the principles governing the construction and operation of steam boilers and their accessories. The object in so doing has been to present information in a form suitable for the use of steam users and engineering students generally. Technical details of boiler construction, such as the pitch of rivets, strength of plates, etc., have been purposely omitted, as few readers will find themselves called upon for expert knowledge on such questions. Only the general principles of the strength of parts has been entered into, and higher mathematics has been eliminated wherever possible. It was obviously out of the question to include a complete discussion of all types of boilers and boiler accessories in a book of this size, but an effort has been made to include those types of equipment which have proved most satisfactory in practice.

THE THEORY OF MACHINES. By Robert W. Angus. 238 pages, 9¼ by 6¼ inches. 147 illustrations. Published by the Engineering Society of the University of Toronto, Toronto, Canada. Price $2.25.

During the writer's experience as an engineer and instructor in engineering subjects, he has had frequent occasion to enter into a discussion of the general theory of the operation of various machine parts. In many cases, it is merely a question of designing such parts to give them sufficient strength, and the principles involved in work of this kind are naturally of the utmost importance in the engineering profession. In such work, however, no direct attempt is made to analyze the conditions under which the machine operates with a view of determining the requirements of size and strength. It was the author's appreciation of the need of such training for engineering students that led to his writing the present book. He does not claim complete originality in the material which he presents, as the current periodicals have been drawn upon wherever desirable information was available. But the quantity of such information was extremely meager and the majority of the text has been developed by the writer, for presentation in this volume.

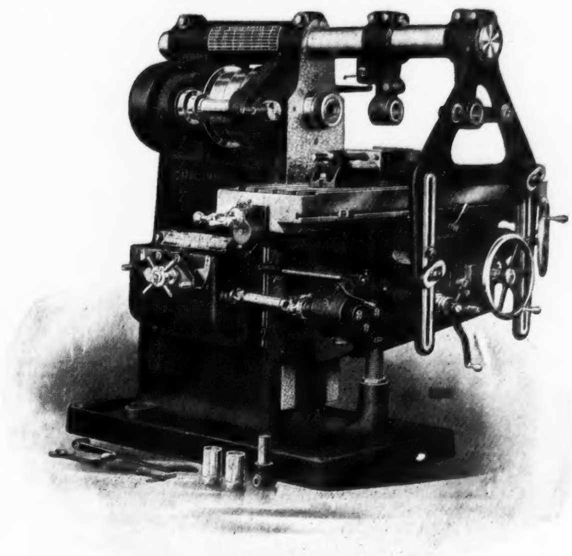
ELEMENTARY MACHINE DRAWING AND DESIGN. By Wm. C. Marshall. 320 pages, 6⅜ by 9⅜ inches. 181 illustrations. Published by McGraw-Hill Book Co., New York. Price $3.

The material in this book has been arranged in such a way that the work can be undertaken by students of engineering who have already had a course in orthographic projection but who are not yet familiar with simple machine elements or with the subjects of mechanics or strength of materials. The simple forms of machine elements are taken up and current drafting-room methods of drawing them are presented, together with the standard practice in proportioning them for different operating conditions. In connection with this part of the work, test problems are presented at the end of each chapter to give the student practice in applying the principle of design which he has gone over. The book is not intended for home study but rather as a supplement to class-room talks on the subject matter presented. On this account detailed instructions have been omitted in many cases in order to allow the instructor the opportunity to vary the presentation of his subject according to individual requirements.

MODERN ORGANIZATION. By Charles De Lano Hine. 110 pages, 7½ by 5¼ inches. Published by the Engineering Magazine Co., New York. Price $2.

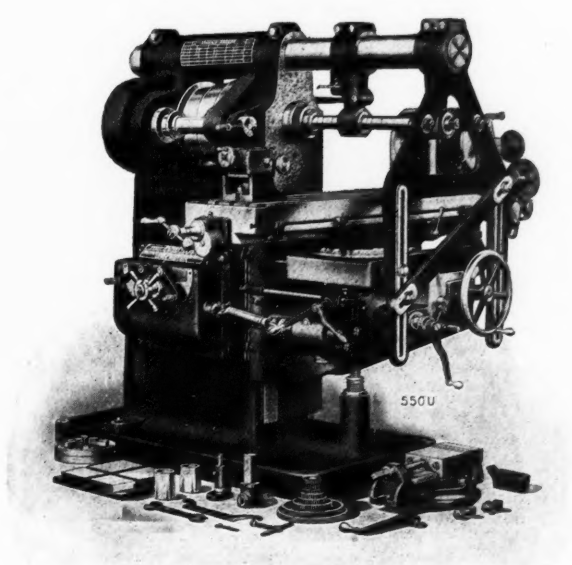
The text of this book was originally presented in a series of articles published in the *Engineering Magazine*, during the period from January to July, 1912, and represents the philosophy of management which Major Hine has had peculiar opportunities of demonstrating. This philosophy, as expressed in the unit system of organization directed toward promoting efficiency in operation in one of the great engineering industries, has been applied upon a scale of magnitude

Much of the Milling in most Shops is not Heavy Cutting



The No. 4 Plain High Power Miller with Cone Drive

Front or operator's side showing arrangement of all operating levers



The No. 4 Universal High Power Miller with Cone Drive

On this work the very powerful single pulley millers do not increase production.

An up-to-date, properly designed, cone-driven machine like our No. 4 Horizontal often proves the better investment.

It is our High Power Miller with cone-driven spindle.

We have simply replaced the Single Pulley, Geared Spindle Drive box with a Double Back Geared Cone of large diameter.

It has ample power for all that work requiring a large machine, but not excessively heavy cutting.

It can be depended upon for long, hard, continuous service, because of its massive "High Power" construction.

Its maintenance cost is low because of its simplicity.

AND IT IS HANDY.

The Feed Changers and Back Gear Lever are where the operator stands to shift the belt.

The Table always feeds in the direction in which the Engaging Lever is set.

This same lever also reverses the feed.

All Controlling Levers are at the front of the knee and saddle. So is the Quick Return.

Everything that has to do with its operation is within easy reach.

And there is an additional lever at the side of the knee controlling the feeds from behind the table, for end-milling or boring or similar work which can't be successfully done when the operator stands in front, as he must do on all other Millers.

Let us help on your milling problems. We make the largest variety of machines and therefore can recommend the ones best suited for your work.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana.

ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

which has only been approached in one other case. Its success was declared with conviction in specially informed circles, but outside of a chosen audience, the characteristics of Major Hine's work had not been effectively presented until the publication of the articles previously referred to. The ideas embodied are so fundamental in character, that it appears certain that they will exercise a powerful influence in many fields of industrial organization. The policies advocated are most interesting because they depend so little upon mechanism of any kind, so little upon systems affecting the rank and file of equipment, and so much upon the psychological influence, bearing first upon, and then through, the directing officials.

MECHANISM. By Robert McArdle Keown. 169 pages, 9⅝ by 6⅝ inches. 168 illustrations. Published by McGraw-Hill Book Co., New York. Price $2.

The material presented in this book is original in its method of presentation rather than in the actual information contained. The advisability of developing this text suggested itself to the writer owing to the desirable results which were obtained in class-room work based upon this arrangement. The distinctive features may be briefly outlined as follows: A discussion of motions, velocities and linkages are first taken up as they are comparatively simple for the student to understand, and problems can be given out in early stages of the class-room work. Cams are dealt with in detail, as they form part of a subject in which considerable practice is required. The involute system of gearing is taken up before the cycloidal system because it is generally easier for the student to grasp the subject when presented in this way. When the underlying principles of the involute system are thoroughly understood, it is generally an easy matter to master the cycloidal system. Furthermore, the use of the involute system is the more general in current practice. Problems are given at the end of each chapter in order that the student may familiarize himself with all of the principles which have been presented.

ELEMENTS OF DRAWING. By George F. Blessing and Lewis A. Darling. 193 pages, 6¼ by 9¼ inches. Published by John Wiley & Sons, New York. Price $1.50.

This book was prepared by the authors at the request of Dexter S. Kimball, professor of machine design and construction, Cornell University. The object in view was two-fold. First, to obtain a book exactly suited to the needs of an elementary course in mechanical drawing for those who were entering upon courses in engineering at Cornell University. Second, to put into permanent form a collection of ideas on the subject which had been accumulated as the result of past years experience. The authors have had experience both as technical educators and as practical engineers. This combination gives them an intimate knowledge of the requirements of the work in hand. Where the book is used as a text in teaching mechanical drawing, the object may be summed up by saying it is to instruct the student: First, how to select, care for, and use drawing instruments; second, how to make and read technical drawings; third, how to think over the drawing-board; fourth, to consider the relation a drawing bears to design, shop processes, and shop organization. In endeavoring to attain the last two objects, the parts of a wood-turning speed lathe have been adopted for models because it is believed that the average student's familiarity with these objects will enable him to combine with his drawing the necessary attention to design and manufacture of the part in question which is essential to the attainment of satisfactory results. The book also gives particularly good treatment to the subject of freehand lettering of drawings and to freehand sketching, both of which are points in which the average draftsman lacks proficiency.

NEW CATALOGUES AND CIRCULARS

ILLINOIS STOKER CO., Alton, Ill. Catalogue of chain grate stokers.

PNEUMATIC JACK CO., Paul Jones Bldg., Louisville, Ky. Circular of the Taylor pneumatic tandem jacks for car repair work and other railway uses.

NATIONAL SCALE CO., Chicopee Falls, Mass. Folder illustrating the National counting machine for counting screws, bolts, nuts, pins, small castings, printed matter, etc.

READY TOOL CO., Bridgeport, Conn. Circular illustrating the Hill compensating milling machine dog, designed especially for use when indexing taper work held on centers.

J. G. BLOUNT CO., Everett, Mass. Catalogue No. 14 on grinding and polishing machinery, and speed lathes, tailstocks, slide-rests, turrets, countershafts and other accessories.

TATE, JONES & CO., INC., Empire Bldg., Pittsburg, Pa. Circulars Nos. 140 and 141 on appliances for burning fuel oil, which apply to all purposes for which oil is used as fuel.

VULCAN ENGINEERING SALES CO., 2014 Fisher Bldg., Chicago, Ill. Circular of QMS jib cranes with hand and power hoists; QMS hand power traveling cranes; and QMS pneumatic hoists.

KEUFFEL & ESSER CO., 127 Fulton St., N. Y. Circular entitled "How to Select Drawing Instruments," illustrating the "Paragon" instruments, and describing their mechanical features.

CROCKER-WHEELER CO., Ampere, N. J. Bulletins Nos. 155 and 156 on Form Q induction motors for operating on 60-cycle polyphase alternating-current circuits, and motor-generator sets for all purposes.

W. S. ROCKWELL CO., 50 Church St., New York. Catalogue No. 15 on rotary annealing and hardening furnaces for annealing, hardening, tempering, blowing or other heat-treatment of brass, copper, steel and other metals.

WATSON-STILLMAN CO., 192 Fulton St., New York. Catalogue No. 84 on hydraulic accumulators and fittings, special hydraulic apparatus, reservoirs, etc. Seven principal types of accumulators are illustrated and described.

FIDELITY & CASUALTY CO., 92 Liberty St., New York. Pamphlet entitled "Steam-Boiler Explosions" by Wm. H. Boehm, an illustrated lecture delivered at Cornell University before the student branch of the A. S. M. E. May 3, 1912.

LUCAS MACHINE TOOL CO., E. 99th St. & L. S. & M. S. Ry., Cleveland, O. Circular describing new model No. 31 "Precision" horizontal boring, drilling and milling machine. The machine is furnished with a vertical milling attachment to order.

READING IRON CO., Reading, Pa. Pamphlet on characteristics of wrought iron pipe and steel pipe, showing the superior qualities of wrought iron pipe. The results of investigations are both interesting and valuable to users of steel and iron exposed to weather conditions.

TRIUMPH ELECTRIC CO., Cincinnati, Ohio. Bulletin No. 501 on "Triumph-Monitor" reversing motor planer drive, showing its application to a Cincinnati planer, the monitor controller, speed curves during reversal of the dynamic brake type, and the "Triumph-Monitor" equipment.

H. BICKFORD & CO., Lakeport, N. H. Leaflet illustrating and describing the 36-inch Bickford vertical chucking machine, designed and placed upon the market to supply the increasing demand for a low-priced, well made tool, suitable for chucking car wheels, gears, pulleys and work of this character.

LANDIS MACHINE CO., Waynesboro, Pa. Catalogue No. 20 on pipe and nipple threading machinery, illustrating the Landis tangent thread chaser, details of the Landis all-steel die-head, and other features of the machine. Six styles and sizes of the machines are illustrated, and specifications given.

PH. BONVILLAIN & E. RONCERAY, Paris, France. Catalogue No. 6 on foundry equipment and supplies, comprising cupolas, ladles, molding machines, furnaces, blowers, molders' tools, core-making machines, core ovens, blow-torches, pneumatic rammers, tumbling barrels, air compressors, templet cutting machines, pyrometers, etc.

VULCAN ENGINEERING SALES CO., 2014 Fisher Bldg., Chicago, Ill. Circular illustrating "Type 1M" cold metal sawing machine, the smallest metal sawing machine made by the company. This machine is especially adapted to meet the requirements of small shops. The machine has a capacity for rounds up to six inches diameter; squares, six inches diameter; and I-beams, ten inches vertical.

AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 343 entitled "Mechanical Draft Forced and Induced by 'Sirocco' and 'A B C' Blowers and Exhaust Fans." The catalogue calls attention to the natural advantages realized with artificial draft produced by mechanical means. It is illustrated with photographs of actual installations with a view to making clear the various methods of applying fans to steam boilers.

FAIRBANKS, MORSE & CO., Wabash Ave. and Eldredge Pl., Chicago, Ill. Pamphlet on the electrical equipment of the Louisville Planing Mill & Hard Wood Flooring Co.'s mill, showing the application of Fairbanks, Morse & Co.'s electric motors to double surfacers, inside molder, and Sturtevant blower. A schedule of all the motors in the installation giving horsepower and names of machines is included.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin 4209 describing the Temple-Ingersoll electric air drill; Bulletin 4023 describing the 4-E type electric air rock drill; Bulletin 4025 describing the 5-F electric air rock drill; Catalogue 384-F giving instructions for installing and operating the Temple-Ingersoll electric air rock drills; and Form 601 giving instructions for operating 5-F machine and list of duplicate parts.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Catalogue No. 10 on small motors for household and other purposes; descriptive leaflet No. 2444 on motor-generator flywheel sets; descriptive leaflet No. 2457 on commutating-pole rotary converters; descriptive leaflet No. 2359-A on direct-current commutating-pole motors—type SK; and descriptive leaflet No. 3506 on installations of paper mill motors for pulp mill service.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4958 on Direct-Current Railways of 1200, 1500 and 2400 volts. This bulletin comprises 129 pages descriptive of electric railway installations and equipment, profusely illustrated with halftones and line engravings; Bulletin No. 4978, Irrigation with Electrically-driven Pumps; Bulletin No. 4932, Electricity in the Brewing Industry; Bulletin No. 4976, Electric Drive in Grain Elevators and Flour Mills.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet entitled "Points About Grinding Wheels and Their Selection," taking up abrasives, bond, grade of wheels, selection of wheels, speed of wheels, combination of wheel and work speeds in cylindrical grinding, mounting wheels, balance of wheels, truing wheels, safety, use of water, suggestions for ordering grinding wheels, list of grinding wheels, suggestions on selection of wheels for use on B. & S. grinding machines, etc.

MESTA MACHINE CO., Pittsburg, Pa. Booklet entitled "Brief Description and Illustrations of the Plant and Product of the Mesta Machine Co., Pittsburg, Pa." This booklet is illustrated with halftones showing the buildings and interior views of the various departments of the company's plant, as well as a great number of illustrations of machines of various types built by the concern, including Corliss engines, air compressors, blowing engines, condensers, hydraulic forging presses.

TRAVELERS INSURANCE CO., Hartford, Conn., have begun the publication of a periodical called the *Travelers' Standard* which will deal with engineering matters of all kinds, but will be mainly concerned with safety engineering, as applied to construction work, manufacturing, mining, power generation and transmission, the electrical and chemical industries, and every other form of activity in which machinery or tools are used. The October number contains an article of general engineering interest entitled, "The Factor of Safety."

B. F. STURTEVANT CO., Hyde Park, Mass. Catalogue No. 205 on gasoline electric generating sets for isolated electric generating plants. These sets are built in 5 K. W., 10 K. W., and 15 K. W. capacities. They are admirably suited for electric lighting and power purposes on farms, country clubs, and other places remote from cities and sources of electric power supply. The catalogue illustrates details of construction, and will be found of general interest to all concerned with the problem of generating electric power with small units.

PENNSYLVANIA RAILROAD CO., Philadelphia, Pa., has issued a booklet for distribution in connection with the semi-centennial of the loyal war governors' conference of September 24, 1862, which was held in Altoona, Pa., September 24-26, 1912. The booklet is illustrated with views of the Conestoga wagon, canal packet on the old Pittsburg line, locomotive "Lancaster" and first steam train to the West; facsimile of original poster advertising schedule and rates to Pittsburg, and facsimile of original poster of schedule Philadelphia to Pittsburg trips in four and one-half days.

ARMSTRONG BROS. TOOL CO., 313 N. Francisco Ave., Chicago, Ill. Catalogue of tool-holders, comprising lathe, planer, shaper, slotter and other tool-holders; boring tools, drill-holders, cutting-off tools, side tools, lathe tool cabinets, knurling tools, grinding holders, cutting-off and grinding machines, high-speed steel, lathe dogs, boxed C clamps, planer jacks, drill drifts, blacksmiths' drill sockets, ratchet drills, drilling posts, drop-forged open-end wrenches, hexagon box wrenches, square box wrenches, construction wrenches, automobile wrench sets, socket wrenches, alligator wrenches, etc.

CROCKER-WHEELER CO., Ampere, N. J. Booklet on Ampere, showing its situation relative to New York and Newark, illustrating the plants, railway station, U. S. post office, interior of shops, and other features of mechanical interest, including one of the C. & C. motors made by the Curtis & Crocker Electric Co., the forerunner of the present Crocker-Wheeler Co. The history of the company includes brief biographies of Dr. Schuyler S. Wheeler and Prof. Francis B. Crocker. The booklet is an unusually interesting and attractive piece of literature on the physical and personal characteristics of a large manufacturing plant.

TRAVELERS INSURANCE CO., Hartford, Conn. Pamphlet on grinding wheels, being one of a series of text-books on safety of operation of plants and machinery. The pamphlet treats of emery wheels, stands, bearings, spindles, belt drive, flanges, washers, fitting of wheels, inspection of wheels, tightening nuts, tool-rests, speed, truth and balance, hoods, goggles, causes of accidents, grindstones, proper mounting and safe speed for same, and polishing wheels. Tables of speeds of emery wheels and grindstones, and illustrations of exhaust hoods,

CONTENTS FOR NOVEMBER

The first column of page numbers applies to the Engineering and Railway Editions: the second to the Shop Edition.

safety hoods, mounting for grinding wheels, etc., are included. The practical information and safety matters given in this little book, make it well worth the attention of every mechanical engineer, superintendent, foreman and mechanic.

Pratt & Whitney Co., Hartford, Conn. General office, 111 Broadway, New York. Catalogue of grinding machines, comprising four-inch by thirty-inch automatic cylindrical sizing grinder, six-inch by forty-eight-inch automatic sizing grinder, and three-foot and six-foot vertical surface grinders; circular illustrating and describing the Pratt & Whitney three-foot vertical surface grinder, and double and quadruple magnetic chucks for the rapid production of ground parts; circular of the Pratt & Whitney vertical shaper, designed to supply the needs of a machine suitable for doing regular slotting work which can also handle the work performed on the horizontal shaper; circulars of thread milling machines, spline milling machines and automatic profiling machines.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. Catalogue No. 71 of Barnes upright drills and other machine tools, comprising friction disk drills of 8- and 10-inch swing; upright drill No. 7, 15-inch swing with cone pulley drive, no back-gears, with or without gear tapping attachment; upright drills Nos. 1, 6, 1½, 2, 5 and 9 of 20, 22, 22½, 25 and 26 inches swing respectively; Nos. 2½ and 3 of 28 and 32 inches swing, respectively; upright drills Nos. 4 and 8 of 42 and 50 inches swing, respectively. Gear tapping attachments are furnished for all sizes of drills from 15 to 50 inches swing. The catalogue also illustrates and describes gang drills, horizontal radial drills, adjustable screw presses, motor drives for upright drills, water emery grinders, chucks, drill sockets, Barnes universal sliding chuck attachment, etc.

TRADE NOTES

National Machine Tool Co., Cincinnati, Ohio, will move into its new plant on Spring Grove Ave., about January 1, 1913.

Herbert L. Towle, advertising specialist, has removed to new offices in the Philadelphia National Bank Bldg., 421 Chestnut St., Philadelphia.

S. A. Woods Machine Co., Boston, Mass., the controlling interest in which was recently purchased by Messrs. C. W. H. Blood and H. C. Dodge, now has the following officers: H. C. Dodge, president, and C. W. H. Blood, vice-president and treasurer. The management in other respects will remain practically the same as before.

Ideal Case Hardening Compound Co., United States Rubber Bldg., New York. Pamphlet on casehardening, pack-hardening and annealing steel, containing in condensed form much useful information on the heat-treatment of steel and practical rules for securing the desired results. The pamphlet is one that should be welcomed by all concerned with the heat-treatment of steel. Sent free upon request.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., is compiling a hand-book for the use of blacksmiths and forge-shop workers, which is expected to fill a long-felt want. The compilers request that blacksmiths and forge-workers send in handy receipts and shop kinks. Credit will be given for all these in the book. The effort is being made to compile the ideas of the leading blacksmiths throughout the country and thus make the book the best of its kind.

Brown Instrument Co., Philadelphia, Pa., and its associated company, the Keystone Electrical Instrument Co., have found a large increase in their shop facilities necessary and have arranged to triple the space after January 1. The two companies have had a very large increase in the demand for their pyrometers, thermometers and electrical instruments, and an increase in their factory equipment is necessary to meet the needs of the constantly growing business.

Walter H. Foster Co., 50 Church St., New York, has opened an office in the McCormick Bldg., Chicago, Ill., under the management of Mr. William Brewster, formerly associated with the Celfor Tool Co. The Walter H. Foster Co. will have the exclusive sale in that section for the Baush Machine Tool Co.'s multiple and radial drills, and the Lassiter bolt machinery; also the Quigley Furnace & Foundry Co. furnaces for all industrial requirements, complete furnace equipments, etc.

Sawyer Tool Mfg. Co., Fitchburg, Mass., maker of machinists' small tools, steel scales, etc., will move about November 1 to Ashburnham, Mass. eight miles from Fitchburg. The company has been in business in Fitchburg over ten years, and better facilities are now required to provide for the growth of the business. Three large brick buildings, affording 84,000 square feet of floor space or about seven times the area of the Fitchburg plant, will be occupied. Mr. Carl H. Hubbell is president of the company.

Hess-Bright Mfg. Co., Philadelphia, Pa., has built a new factory and office at Front St. and Erie Ave., having a frontage of 200 feet and a depth of 235 feet. The entire second floor, to the depth of 35 feet, is devoted to offices. Back of the offices the building is one-story high with sawtooth roof. The bulk of the company's product is imported, and the output of the shops will represent but a small proportion of the entire business. The present building forms the nucleus of a much larger plant which is eventually to be erected.

Greenfield Tap & Die Corporation, Greenfield, Mass., a holding company that controls the stock of the Wiley & Russell Mfg. Co. and Wells Brothers Co., acquired the entire stock of the A. J. Smart Mfg. Co. on October 1. The A. J. Smart Mfg. Co. was organized six years ago and quickly established a name for the manufacture of the highest class of taps, dies and screw plates. The company will be continued as a separate organization, and conditions are extremely favorable for the continuation of its rapid growth. The new officers are: President, F. O. Wells; vice-president, Rollin S. Bascom; treasurer and clerk, F. H. Payne; directors, the above, and M. Pratt and J. W. Stevens.

Taylor Iron & Steel Co., High Bridge, N. J., has acquired the business of Wm. Wharton, Jr., & Co., Inc. of Philadelphia, with works at Philadelphia and Jenkintown Pa., and its subsidiary corporation the Philadelphia Roll & Machine Co. The Taylor Co. and the Wharton Co. have both been in business more than fifty years. During the last eighteen years, the business of each company has been largely supplementary to the other in the application and manufacture of manganese steel, and the relations have become so close that a unity of interest has been found advisable. The new concern will be known as the Taylor-Wharton Iron & Steel Co., and the officers will be as follows: President, Knox Taylor; vice-presidents, A. E. Borie, Prof. H. M. Howe and V. Angerer; secretary and treasurer, W. A. Ingram.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

an exceptionally good man to take charge. He must be a rapid, all-round machinist and tool maker, with a knowledge of blanking, forming and drawing dies, and novelty manufacture. He must be able to make close estimates on jobbing work, and then make good on the estimates. My present foreman is leaving to engage in other business. If I can get as capable a successor I am willing to pay well, and in addition would give a substantial interest in the business. I have a clean, light shop, with modern machine tools. There must be many men capable of filling the position who would be glad to escape the rigorous winters of the East to come to sunny California. Applicants should write, explaining fully their qualifications, age, nationality, etc. I will reply, giving more particulars. If this does not interest you, try to think of some friend whom it will. Address Box 495, care MACHINERY, 49 Lafayette St., New York.

BENCH LATHE KNURLING TOOLS.—SEVERANCE TOOL CO., Newark, N. J.

BUSINESS OPPORTUNITY.—For Sale.—The patents, patterns and good-will in a wood working specialty, business established in 1886. Company now engaged in making this machine, also making a large line of metal working machines, and desires to dispose of the wood working branch. Splendid opportunity for any one wishing to start in the manufacturing business; or one already established who desires to take on a good paying tool having a world-wide reputation. Address Box 502, care MACHINERY, 49 Lafayette St., New York.

CONTRACT MANUFACTURING.—We have a well equipped machine shop with all kinds of modern tools for making machinery of every description; also all kinds of experimental work. We solicit your orders and inquiries. DARIEN MACHINE COMPANY, N. E. Cor. Darien and Noble Sts., Philadelphia, Pa.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsibile references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

ENGINEERS, SUPERINTENDENTS, Designers, Draftsmen, Engineering Salesmen, Production Engineers and Mechanical Foremen will find it to their advantage to investigate our method of securing employment. Unless record can stand investigation don't bother about answering this ad. THE ENGINEERING AGENCY, INC. (Est. 1893), Monadnock Block, Chicago.

FOR RENT—FOR SALE—Up-to-date Brass and Steel machine shop, completely equipped, *now running,* including established business, $40,000 annually. New building, single story; concrete; 10,000 square feet; splendid power plant; fronts two paved streets; Newark factory district; large plot. Will sell land and business at invoice value. $83,500, or rent whole outfit, machinery, etc., for term of years. FRANCES, Newark, N. J.

FOR SALE.—I wish to dispose of my patents, just issued, on Nut Tapping Machine. Address CARL BAERWALDE, Cleveland, Ohio.

FOR SALE.—One 36-inch Planer, 9-ft. bed. L. W. Pond Mch. Company's make; single tool post and power feed; countershaft for belt drive. In excellent working order. Price $800.00. THE PORTSMOUTH ENGINE COMPANY, Portsmouth, Ohio.

FOR SALE.—One 72-inch Vertical Boring Mill with five step cone pulley and back gear. Heavy 5-inch vertical boring spindle with power feed of 20 inches. Countershaft drive. Floor space 10 feet 6 inches by 8 feet. In excellent working order. Price $550.00. THE PORTSMOUTH ENGINE COMPANY, Portsmouth, Ohio.

FOR SALE.—Small power plants, steam or gas. Send for list. J. L. LUCAS & SON, Bridgeport, Conn.

FOR SALE.—One right hand C. & G. Cooper girder frame Corliss engine, cylinder 10½-inch bore by 30-inch stroke, 100 R. P. M., developing 75 horsepower at 90 pounds steam pressure; 8-foot fly wheel with 15-inch face. Removed to replace with greater capacity. Low price for quick sale. STATE JOURNAL COMPANY, Lincoln, Nebraska.

FOR SALE.—Plant located at Reynoldsville, Pa., on Allegheny Valley and B. R. & P. Railroads; 10 acres of ground; four buildings, consisting of Upper Shop, approximately 360 feet x 65 feet, Lower Shop, approximately 220 feet x 75 feet, two-story Office Building and Storage House; three Boilers, each 150 H. P.; one Generator 150 kilowatts. Plant suitable for Sheet Metal, Light Structural or Light Foundry Work. Smaller shop equipped for traveling crane. Will be sold cheap, on reasonable terms. Address B. L. H., Room 1204, Westinghouse Building, Pittsburg, Pa.

FOR SALE—PATENTS, ESTABLISHED BUSINESS AND EQUIPMENT FOR MANUFACTURING A WELL ADVERTISED MACHINE TOOL. The tool has a good standing, is well known among users and would make a good business in itself. Specializing on a single machine is our reason for selling, and we can make an interesting proposition to any concern looking for such an opportunity. Address "OPPORTUNITY," Box 500, care MACHINERY, 49 Lafayette St., New York.

FOR SALE.—Portable one hose vacuum cleaning wagon. Blaisdell system. 10 H. P. engine, 8 x 4 double cylinder vacuum pump, magneto, etc.; fully equipped in excellent condition; Studebaker wagon. Sold low if sold at once. Address CHAS. H. DOWNES, 9 Courtland Place, So. Norwalk, Conn.

HAND SCREW MACHINE OPERATORS, milling machine hands and boring machine Bullard operators. First class only. Steady employment to good men. F. I. A. T., Poughkeepsie, N. Y.

HELP WANTED.—Roadmen, Draftsmen and Foreman for Testing Department; large factory making gas engines from 2 to 500 horsepower. Only men of experience will be considered. Write fully regarding experience, salary expected, etc. Address Box 494, care MACHINERY, 49 Lafayette St., New York.

INSPECTOR WANTED.—Good all round mechanic for Philadelphia company, manufacturing small brass parts similar to plumbing supply goods. One who has had shop experience and is capable of acting as foreman if necessary. State age, experience, reference and salary desired. Address Box 497, care MACHINERY, 49 Lafayette St., New York.

INVENTORS—I procure best protecting patents, rates reasonable. My "Treatise on Patents" free. BENJAMIN ROMAN, Park Row Building, New York.

MACHINIST WANTED IN DETROIT.—Experienced planer, boring mill hand and a good layer out with a firm making hoisting machinery. Address Box 483, care MACHINERY, 49 Lafayette St., New York.

MACHINE WORK WANTED.—Let us quote you our estimates on any kind of machine work. We have a well equipped factory and can do the work right. Send your blueprints to JOHN L. SMITH & SONS, 613 Catherine St., Syracuse, N. Y.

PATENTABLE IDEA FOR SALE.—Lack of money forces me to sell my ideas on a household article of sterling value, very cheap. Nothing like it on the market. I have orders for twenty as soon as manufactured, from giving a description of it only, which warrants it a money-maker for the promoter. The specification papers are completed and it is in the hands of a registered attorney at Washington. Would like to hear from some one who means business at once. I will guarantee every statement I make. Address Box 504, care MACHINERY, 49 Lafayette Street, New York.

PATENT FOR SALE—MOLDING MACHINE.—Reliable and accurate machine preferably for production in quantities, and producing 130 molds per day, size 17½ by 13½ inches. Address Box 498, care MACHINERY, 49 Lafayette St., New York.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. Trade-marks registered.

PHOTOGRAPHER—DRAFTSMAN.—A large manufacturing company in Saint Louis wants an experienced photographer thoroughly familiar with machinery subjects and who is also a mechanical draftsman. Permanent position. Salary $75.00 per month with opportunity for advancement. Address P. O. Box 824, New York City.

POSITION WANTED as assistant superintendent or foreman by tool and machine designer with ten years of shop and drawing room experience. Accustomed to automatic machinery, tools, dies, jigs and fixtures. References. Address Box 503, care MACHINERY, 49 Lafayette St., New York.

POSITION WANTED.—By man of large experience as general manager with an engine or machinery manufacturing concern, which has a good business but whose returns are not what they should be. I can prove my ability to produce a profit if it is possible. Address Box 496, care MACHINERY, 49 Lafayette St., New York.

SEND YOUR CATALOG, PLEASE.—We want latest catalogs and circulars on Machine Tools and Shop Appliances, for filing and reference. W. H. McELWAIN CO., Manchester, N. H.

SUCCESS THROUGH INVENTION is realized with good patents properly promoted. Efficient patent service means protected inventions easy to promote. Terms reasonable. JOSEPH J. O'BRIEN, Patent Attorney; member Franklin Institute; National Geographical Society. Opposite U. S. Patent Office, Washington, D. C.

SUPERINTENDENT desired for machine shops of large German manufacturing establishment for light electrical machinery; graduate of technical or trade school preferred; able to handle 1000 men. Must be experienced in the quantity production of small parts, in construction of special machines, tools and dies, and must have a thorough shop experience with modern machine tools, especially punching, milling, drilling and gear cutting machinery. Knowledge of German imperative. Good permanent position for the right man. State former experience and salary expected. Address Box 499, care MACHINERY, 49 Lafayette St., New York.

TEST INDICATORS.—H. A. LOWE, 1374 East 88th St., Cleveland, Ohio.

THE METHODS OF INVENTORS, by THE U. S. PATENT OFFICE, with chart illustrative of workings of entire Patent System, by Editor of THE INVENTORS' OUTLOOK, and two months' subscription for 25c. cash. Invaluable to inventors and mechanics. 819 G St., Washington, D. C.

TOOL-HARDENING—CASE-HARDENING.—C. U. SCOTT, Davenport, Iowa.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say, "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic, valuable information condensed in pocket size. Price postpaid $1.00, cloth; $1.25, leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Copies MACHINERY, Engineering Edition, issues September, October, November and December, 1906; also April, May, June and July, 1908. State price. Box 501, care MACHINERY, 49 Lafayette St., New York.

WANTED—DIE SINKERS on Drop Forged Work, also Drop Forgers. Must be first class men, able to earn highest wages paid. Address Employment Dep't., THE BILLINGS & SPENCER COMPANY, Hartford, Conn.

WANTED IN PENNSYLVANIA.—By first-class machine tool concern. Man who is thoroughly familiar with inspection and premium systems. Must be a man who has done executive work in these lines in some up-to-date machine tool concern. A man who is able to work out the executive end of the premium system and who thoroughly understands inspection of the machine tool class. In reply state age, whether married or single, compensation received in previous positions and what is expected at the present time. Only absolutely reliable, efficient man need apply. Address Box 487, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Let us quote you on casting and machining small brass parts. Address Box 489, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Practical men (familiar with scientific management methods), capable of making detailed time studies of various manufacturing operations and to actually perform the operations when necessary. Give in detail experience and salary expected. Address P. O. Box 911, Pittsburg, Pa.

WANTED.—SUPERINTENDENT IMMEDIATELY TO GERMANY. Large factory (in Germany) making small electric motors up to 1 H. P. wants an expert engineer at once to superintend the making of motors. Must be expert on efficient and economical winding, and armature and commutator production in large quantities. Only a critical expert, with past record on large output to prove it, will be considered. State at once education, experience, past and present employment, age, when free to make new connection and salary desired. Send photograph. Address Box 491, care MACHINERY, 49 Lafayette St., New York.

WELLES TOOLS are different. Get a catalogue and price list. WELLES CALIPER COMPANY, Milwaukee, Wis.

YOUNG MECHANICAL ENGINEER with broad shop experience desires a change. Thoroughly posted on machine tools and modern manufacturing practice. Capable of handling practical and theoretical shop problems. Some experience, correspondence, office and commercial end. Would like to connect with manufacturer of high grade product where the prospects for advancement are good. Location anywhere. Address Box 486, care MACHINERY, 49 Lafayette St., New York.

Tables for Article in this number entitled "Fluting Angular Mi

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—I

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
Number of Teeth in Cutter to be Fluted = 6										
20	70	23° 18′	0.020	0.7575	0.040	0.7395	0.080	0.7011	0.120	0.6651
	80	39° 40′		0.5251		0.5125		0.4875		0.4625
30	70	16° 32′	0.020	0.7751	0.040	0.7575	0.080	0.7200	0.120	0.6832
	80	29° 22′		0.5750		0.5605		0.5329		0.5020
40	70	11° 58′	0.020	0.7875	0.040	0.7661	0.080	0.7295	0.120	0.6920
	80	21° 48′		0.6035		0.5877		0.5590		0.5310
45	70	10° 12′	0.020	0.7900	0.040	0.7700	0.080	0.7320	0.120	0.6968
	80	18° 44′		0.6120		0.5970		0.5678		0.5395
50	70	8° 39′	0.020	0.7912	0.040	0.7710	0.080	0.7330	0.120	0.6980
	80	15° 59′		0.6190		0.6039		0.5725		0.5450
60	70	6° 2′	0.020	0.7925	0.040	0.7750	0.080	0.7360	0.120	0.6998
	80	11° 12′		0.6300		0.6155		0.5850		0.5551
70	70	3° 49′	0.020	0.7960	0.040	0.7782	0.080	0.7390	0.120	0.7005
	80	7° 10′		0.6340		0.6200		0.5900		0.5595
80	70	1° 52′	0.020	0.7965	0.040	0.7787	0.080	0.7395	0.120	0.7010
	80	3° 30′		0.6355		0.6210		0.5910		0.5601
Number of Teeth in Cutter to be Fluted = 8										
20	60	31° 53′	0.020	0.6380	0.040	0.6210	0.080	0.5901	0.120	0.5478
	70	43° 53′		0.4550		0.4434		0.4219		0.3900
	80	53° 45′		0.2895		0.2825		0.2682		0.2481
30	60	24° 12′	0.020	0.6555	0.040	0.6397	0.080	0.6071	0.120	0.5650
	70	34° 25′		0.4849		0.4725		0.4490		0.4162
	80	42° 55′		0.3298		0.3224		0.3052		0.2835
40	60	18° 15′	0.020	0.6681	0.040	0.6501	0.080	0.6172	0.120	0.5715
	70	26° 33′		0.5048		0.4925		0.4675		0.4331
	80	33° 36′		0.3582		0.3491		0.3319		0.3067
45	60	15° 48′	0.020	0.6701	0.040	0.6530	0.080	0.6205	0.120	0.5754
	70	23° 8′		0.5111		0.4983		0.4740		0.4391
	80	29° 25′		0.3710		0.3608		0.3433		0.3170
50	60	13° 33′	0.020	0.6724	0.040	0.6541	0.080	0.6235	0.120	0.5767
	70	20° 0′		0.5190		0.5032		0.4778		0.4438
	80	25° 30′		0.3785		0.3680		0.3507		0.3240
60	60	9° 37′	0.020	0.6761	0.040	0.6600	0.080	0.6281	0.120	0.5801
	70	14° 20′		0.5249		0.5112		0.4860		0.4485
	80	18° 24′		0.3900		0.3801		0.3600		0.3349
70	60	6° 10′	0.020	0.6810	0.040	0.6626	0.080	0.6300	0.120	0.5804
	70	9° 14′		0.5335		0.5187		0.4930		0.4552
	80	11° 55′		0.4021		0.3910		0.3690		0.3425
80	60	3° 2′	0.020	0.6750	0.040	0.6646	0.080	0.6250	0.120	0.5800
	70	4° 30′		0.5350		0.5225		0.4961		0.4595
	80	5° 50′		0.4065		0.3980		0.3777		0.3497

Contributed by George W. Burley

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—II

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
Number of Teeth in Cutter to be Fluted = 10										
20	45	24° 18′	0.020	0.7840	0.040	0.7091	0.080	0.6591	0.120	0.6091
	50	32° 0′		0.6215		0.6019		0.5627		0.5235
	60	43° 18′		0.4606		0.4451		0.4140		0.3829
	70	51° 50′		0.3204		0.3094		0.2875		0.2656
	80	59° 4′		0.1947		0.1881		0.1749		0.1617
30	45	18° 14′	0.020	0.7422	0.040	0.7160	0.080	0.6636	0.120	0.6112
	50	24° 45′		0.6430		0.6204		0.5742		0.5299
	60	34° 30′		0.4800		0.4630		0.4290		0.3950
	70	42° 8′		0.3433		0.3312		0.3070		0.2828
	80	48° 30′		0.2225		0.2135		0.1956		0.1777
40	45	12° 30′	0.020	0.7680	0,040	0.7421	0.080	0.6903	0.120	0.6385
	50	18° 55′		0.6500		0 6275		0.5826		0.5376
	60	27° 3′		0.4918		0.4746		0.4403		0.4060
	70	33° 31′		0.3601		0.3431		0.3210		0.2953
	80	38° 50′		0.2439		0.2355		0.2187		0.2019
45	45	11° 47′	0.020	0.7500	0.040	0.7235	0.080	0.6705	0.120	0.6175
	50	16° 10′		0.6591		0.6394		0.5999		0.5604
	60	23° 40′		0.4975		0.4700		0.4450		0.4100
	70	29° 24′		0.3682		0.3553		0.3294		0.3036
	80	34° 20′		0.2528		0.2439		0.2260		0.2081
50	45	10° 7′	0.020	0.7465	0.040	0.7206	0.080	0.6687	0.120	0.6168
	50	14° 10′		0.6539		0.6311		0.5856		0.5400
	60	20° 31′		0.5000		0.4826		0.4479		0.4131
	70	25° 40′		0.3725		0.3594		0.3333		0.3072
	80	30° 1′		0.2601		0.2510		0.2327		0.2145
60	45	7° 8′	0.020	0.7500	0.040	0.7240	0.080	0.6720	0.120	0.6200
	50	10° 5′		0.6595		0.6363		0.5898		0.5433
	60	14° 50′		0.5049		0.4875		0.4528		0.4181
	70	18° 37′		0.3804		0.3673		0.3411		0.3149
	80	21° 56′		0.2709		0.2613		0.2422		0.2231
70	45	4° 34′	0.020	0.7503	0.040	0.7243	0.080	0.6723	0.120	0.6203
	50	6° 30′		0.6598		0.6389		0.5920		0.5451
	60	9° 36′		0.5101		0.4924		0.4568		0.4212
	70	12° 8′		0.3872		0.3730		0.3460		0.3190
	80	14° 20′		0.2785		0.2688		0.2494		0.2300
80	45	2° 14′	0.020	0.7498	0.040	0.7238	0.080	0.6719	0.120	0.6200
	50	3° 10′		0.6603		0.6376		0.5923		0.5469
	60	4° 45′		0.5078		0.4902		0.4550		0.4198
	70	6° 0′		0.3875		0.3740		0.3470		0.3200
	80	7° 5′		0.2820		0.2724		0.2532		0.2840

Contributed by George W. Burley

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—III

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—III

Number of Teeth in Cutter to be Fluted = 12

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	36° 0′		0.5718		0.5480		0.5004		0.4528
	50	40° 40′		0.5017		0.4807		0.4387		0.3967
20	60	49° 19′	0.020	0.3620	0.040	0.3470	0.080	0.3170	0.120	0.2870
	70	56° 1′		0.2475		0.2371		0.2163		0.1955
	80	61° 50′		0.1454		0.1393		0.1271		0.1149
	45	28° 8′		0.5806		0.5566		0.5086		0.4606
	50	32° 32′		0.5128		0.4912		0.4480		0.4048
30	60	40° 12′	0.020	0.3760	0.040	0.3602	0.080	0.3286	0.120	0.2970
	70	46° 15′		0.2649		0.2537		0.2313		0.2089
	80	51° 25′		0.1657		0.1589		0.1453		0.1317
	45	22° 0′		0.5890		0.5642		0.5146		0.4650
	50	25° 38′		0.5191		0.4973		0.4537		0.4101
40	60	32° 2′	0.020	0.3870	0.040	0.3708	0.080	0.3384	0.120	0.3060
	70	37° 15′		0.2769		0.2653		0.2421		0.2189
	80	41° 44′		0.1803		0.1727		0.1575		0.1423
	45	18° 55′		0.5981		0.5729		0.5225		0.4721
	50	22° 13′		0.5260		0.5040		0.4600		0.4160
45	60	28° 19′	0.020	0.3920	0.040	0.3752	0.080	0.3416	0.120	0.3080
	70	33° 0′		0.2832		0.2714		0.2478		0.2242
	80	37° 6′		0.1865		0.1787		0.1631		0.1475
	45	16° 31′		0.5980		0.5728		0.5224		0.4720
	50	19° 27′		0.5261		0.5039		0.4595		0.4150
50	60	24° 48′	0.020	0.3950	0.040	0.3784	0.080	0.3452	0.120	0.3120
	70	28° 54′		0.2878		0.2757		0.2515		0.2273
	80	32° 38′		0.1937		0.1857		0.1697		0.1537
	45	12° 12′		0.5960		0.5652		0.5156		0.4660
	50	14° 13′		0.5245		0.5001		0.4573		0.4145
60	60	18° 0′	0.020	0.4000	0.040	0.3834	0.080	0.3502	0.120	0.3170
	70	21° 10′		0.2950		0.2826		0.2578		0.2330
	80	23° 58′		0.2021		0.1935		0.1763		0.1591
	45	8° 0′		0.5875		0.5629		0.5137		0.4645
	50	9° 8′		0.5300		0.5080		0.4640		0.4200
70	60	11° 45′	0.020	0.4035	0.040	0.3865	0.080	0.3525	0.120	0.3185
	70	13° 54′		0.2986		0.2864		0.2620		0.2376
	80	15° 45′		0.2082		0.1994		0.1818		0.1642
	45	3° 46′		0.6005		0.5753		0.5249		0.4745
	50	4° 30′		0.5298		0.5078		0.4638		0.4198
80	60	5° 48′	0.020	0.4049	0.040	0.3879	0.080	0.3539	0.120	0.3199
	70	6° 51′		0.3040		0.2912		0.2656		0.2400
	80	7° 48′		0.2120		0.1932		0.1756		0.1680

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—IV

Number of Teeth in Cutter to be Fluted = 14

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
	45	42° 5′		0.4755		0.4525		0.4065		0.3605
	50	46° 0′		0.4132		0.3932		0.3532		0.3132
20	60	53° 4′	0.020	0.2960	0.040	0.2817	0.080	0.2531	0.120	0.2245
	70	58° 40′		0.2000		0.1902		0.1706		0.1510
	80	63° 30′		0.1150		0.1094		0.0982		0.0870
	45	33° 51′		0.4860		0.4630		0.4170		0.3710
	50	37° 27′		0.4226		0.4019		0.3607		0.3195
30	60	43° 50′	0.020	0.3069	0.040	0.2921	0.080	0.2625	0.120	0.2329
	70	48° 52′		0.2128		0.2024		0.1816		0.1608
	80	53° 15′		0.1294		0.1232		0.1108		0.0984
	45	26° 39′		0.4945		0.4705		0.4225		0.3745
	50	29° 50′		0.4296		0.4086		0.3666		0.3246
40	60	35° 20′	0.020	0.3150	0.040	0.2996	0.080	0.2688	0.120	0.2380
	70	39° 40′		0.2231		0.2123		0.1907		0.1691
	80	43° 30′		0.1410		0.1342		0.1206		0.1070
	45	23° 24′		0.4959		0.4719		0.4239		0.3759
	50	26° 10′		0.4360		0.4146		0.3718		0.3290
45	60	31° 19′	0.020	0.3198	0.040	0.3042	0.080	0.2730	0.120	0.2418
	70	35° 18′		0.2275		0.2165		0.1945		0.1725
	80	38° 45′		0.1470		0.1398		0.1254		0.1110
	45	20° 30′		0.4970		0.4730		0.4250		0.3770
	50	22° 59′		0.4370		0.4156		0.3728		0.3300
50	60	27° 27′	0.020	0.3225	0.040	0.3069	0.080	0.2757	0.120	0.2445
	70	31° 0′		0.2320		0.2208		0.1984		0.1760
	80	34° 10′		0.1510		0.1436		0.1288		0.1140
	45	15° 14′		0.4980		0.4740		0.4260		0.3780
	50	16° 45′		0.4384		0.4168		0.3736		0.3304
60	60	20° 5′	0.020	0.3280	0.040	0.3120	0.080	0.2800	0.120	0.2480
	70	22° 50′		0.2371		0.2257		0.2029		0.1801
	80	25° 15′		0.1572		0.1496		0.1344		0.1192
	45	9° 45′		0.4986		0.4746		0.4266		0.3786
	50	10° 55′		0.4410		0.4192		0.3756		0.3320
70	60	13° 11′	0.020	0.3325	0.040	0.3163	0.080	0.2839	0.120	0.2515
	70	15° 0′		0.2437		0.2317		0.2077		0.1837
	80	16° 39′		0.1632		0.1552		0.1392		0.1232
	45	5° 0′		0.4990		0.4750		0.4270		0.3790
	50	5° 21′		0.4420		0.4202		0.3766		0.3330
80	60	6° 32′	0.020	0.3330	0.040	0.3170	0.080	0.2850	0.120	0.2530
	70	7° 29′		0.2474		0.2348		0.2096		0.1844
	80	8° 15′		0.1676		0.1594		0.1430		0.1266

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912